# AMERICAN SEWAGE DISPOSAL SYSTEM

# AMERICAN SEWAGE DISPOSAL COMPANY

OF BOSTON

85 INTERNATIONAL TRUST BUILDING
45 MILK STREET, BOSTON, MASS.

Telephone, 2445-3 Main

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**Organized for Designing and Constructing Sewers and Sewage Disposal Works under the Glover and McClintock Patents**

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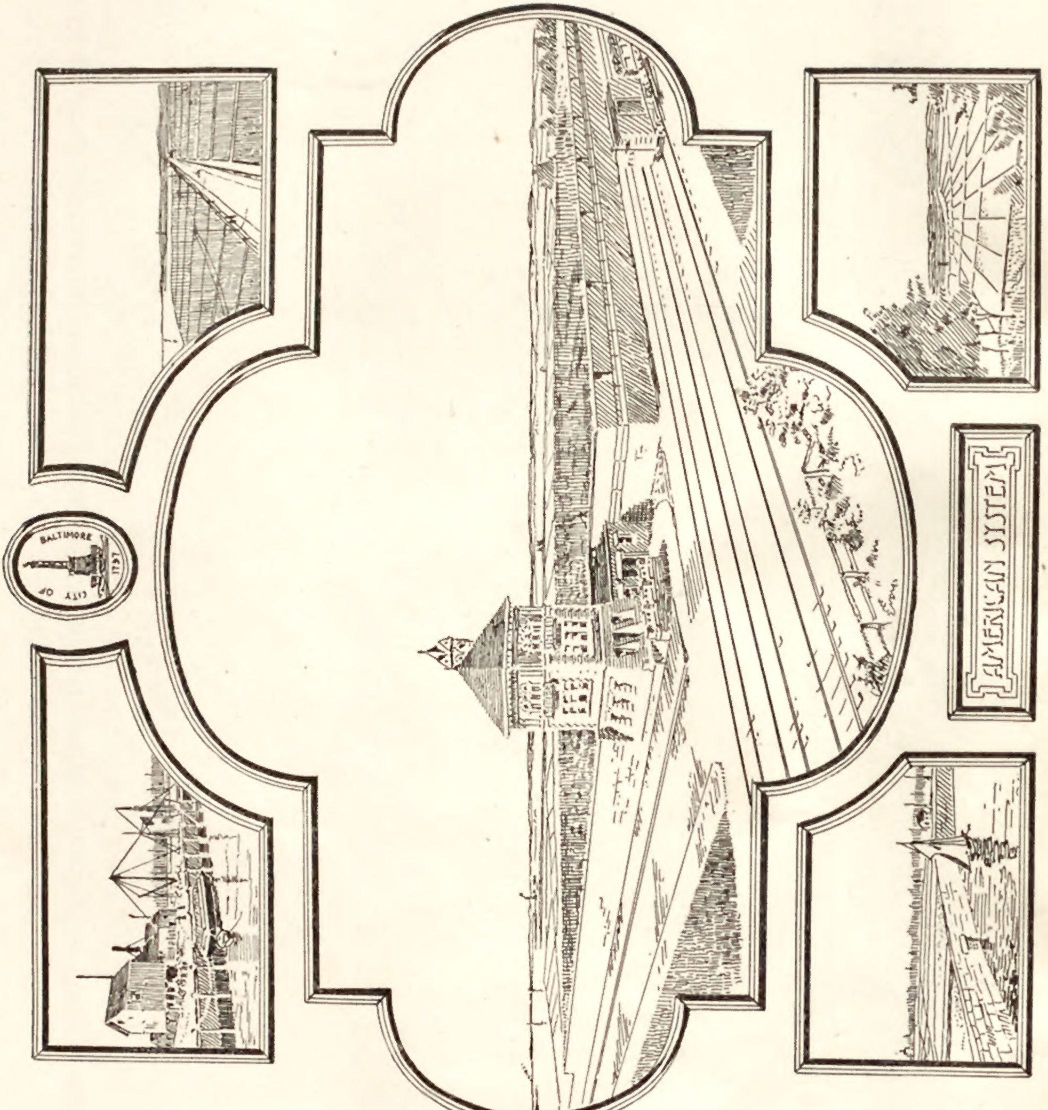

AMERICAN SYSTEM
BALTIMORE
CITY OF
1797

Second Edition.
1903.

# SEWER BUILDING
AND
# SEWAGE DISPOSAL
BY THE
# AMERICAN SYSTEM

DISCOVERED BY AMASA S. GLOVER

PROTECTED BY UNITED STATES PATENTS NOS. 559522 AND 719357
OWNED BY AMERICAN SEWAGE DISPOSAL COMPANY OF BOSTON


BY

JOHN N. McCLINTOCK, A.M., C.E.

CONSULTING CIVIL AND SANITARY ENGINEER; LATE SUB-ASSISTANT SUPERINTENDENT UNITED STATES COAST SURVEY; INSTRUCTOR OF GEODESY AND COAST SURVEY METHODS AT BOWDOIN COLLEGE; EXPERT FROM MANY YEARS' PRACTICAL EXPERIENCE IN GEODETIC WORK, TRIANGULATION, TOPOGRAPHY AND HYDROGRAPHY, MUNICIPAL, RAILROAD, MINING AND SANITARY ENGINEERING, LANDSCAPE ARCHITECTURE, CONSTRUCTION OF WATER PURIFICATION WORKS, SEWERS AND SEWAGE DISPOSAL WORKS

PRESIDENT AND GENERAL MANAGER




BOSTON
1903

# SEWER BUILDING.

It is possible to build sewers in any place where human habitation is feasible, and to so care for the sewage that it will not be offensive in any sense. To properly plan a system of sewers and sewage disposal works for a locality, it is of the utmost importance that a topographical map of the section to be drained be first prepared, giving the grade of the streets, depth of the cellars, and the general conformation of the territory. It is generally possible to carry the sewage by gravitation to some point where it can be treated more or less elaborately, according to the degree of purification demanded, and other conditions. If gravity can be depended upon to care for the effluent, or purified water from tanks or filter beds, the problem of sewage disposal is greatly simplified.

2. The second step necessary after a topographical survey is the general design of a system of sewers, and of sewage disposal works. Here is where a village, town or city require the services of an expert and experienced civil engineer, one who has made himself familiar not only with the successful achievements of other engineers in the past, but is posted as to the mistakes and failures made in all parts of the world.

3. The scheme having been devised and approved by the proper authorities, plans for building and record should be made.

4. A contracting party should be obtained, and proper supervision furnished. If a city or town would undertake to do its own work, experienced surveyors and foremen for brick-work and stonework, manholes, catch-basins, pipe-laying and blasting should be provided, and the line and grade adhered to faithfully.

# COST OF SEWERS.

In considering the construction of a sewer system, a rough estimate of the probable cost is generally sought.

The preliminary topographical plan will cost from 50 cents to $3.00 per acre of territory to be drained, according to the characteristics of the surface, whether flat or diversified, thinly or thickly settled.

A well considered design may cost from 2 to 10 cents per inhabitant, according to the size of the place; making plans for building and record will cost from $20.00 to $40.00 per mile of sewer pipe.

A twelve-inch pipe with proper inlets can be laid eight feet below the surface for $1.00 per foot. If ledge is encountered the cost is increased. Ledge work will cost from $2.00 to $5.00 per cubic yard, according to the hardness of the stone and depth below the surface. Manholes and catch-basins averaging 150 feet apart will cost about $35.00 or $40.00 each.

The separate system for sewage and surface water is usually recommended, with proper appliances for flushing, to save cost of work. Disposal works will cost approximately from $1.00 to $2.00 per inhabitant. Plans for the same may be furnished at 5% of their cost. Chemical precipitation will cost per year 20 cents per inhabitant. The cost of the trunk sewers of a system, of course, will depend upon their size.

A completed sewer system in running order will cost from $2.00 to $4.00 per running foot or from $10,000 to $20,000 per mile, for a place of considerable size. Small systems will cost less.

The American Sewage Disposal Company of Boston will furnish plans, estimates and supervision for 10% of cost of construction, or it will build the sewers and disposal works, or either, at cost and accept 10% additional for plans, supervision and profits.

# DESIGN AND CONSTRUCTION OF SEWERS.

The American Sewage Disposal Company of Boston offer their services to properly equip any community with sewers and disposal works. They will furnish expert surveyors for making preliminary plans, expert civil engineers for designing sewer systems and sewage disposal works, experienced and skilful sewer constructors, pipe-layers, stone-men, masons, engineers, inspectors, foremen and workmen. There are many small towns without an engineer experienced in sewer construction and sewage disposal works. This company is prepared to undertake the work of designing and building for such towns. They will take the contract, or let it to lowest bidder, and supervise construction. They will make an equitable arrangement with any community desiring their services.

The business which the company seeks is not only the planning and construction of sewers and disposal works, but the continued operation and maintenance of the same under contract and under bond, so that skilled labor and responsible workmen will attend to keeping up the efficiency of the system, more especially of the disposal works.

Skill, experience, and judgment are demanded for the proper construction of sewers, manholes, catch-basins, flushing tanks, and disposal works.

A system however perfect may be ruined or impaired in its operation by the lack of engineering skill, experience in sewer construction, and common sense in building it. For instance, a sewer laid without regard to a grade line, following the irregularities of the surface, forming depressions and elevations, laid without close-fitting and cemented joints, without manholes or ventilation, built by unskilled labor, inspected by idiots, supervised by ignorance and stupidity, clothed with brief authority, to save fees for legitimate professional services, is bound to come to grief.

# SEWAGE DISPOSAL WORKS.

The American Sewage Disposal Company of Boston have come into possession of valuable patent rights covering sewage disposal by septic tanks and single and double intermittent filtration, with necessary ventilation; and they are prepared not only to construct sewers, but also disposal works to entirely or partially remove the impurities from the sewage. Their system prevents the pollution of harbor, river, lake, or sea-shore, and covers broad irrigation, intermittent filtration, chemical precipitation, and the recovery of the manurial value of the sewage.

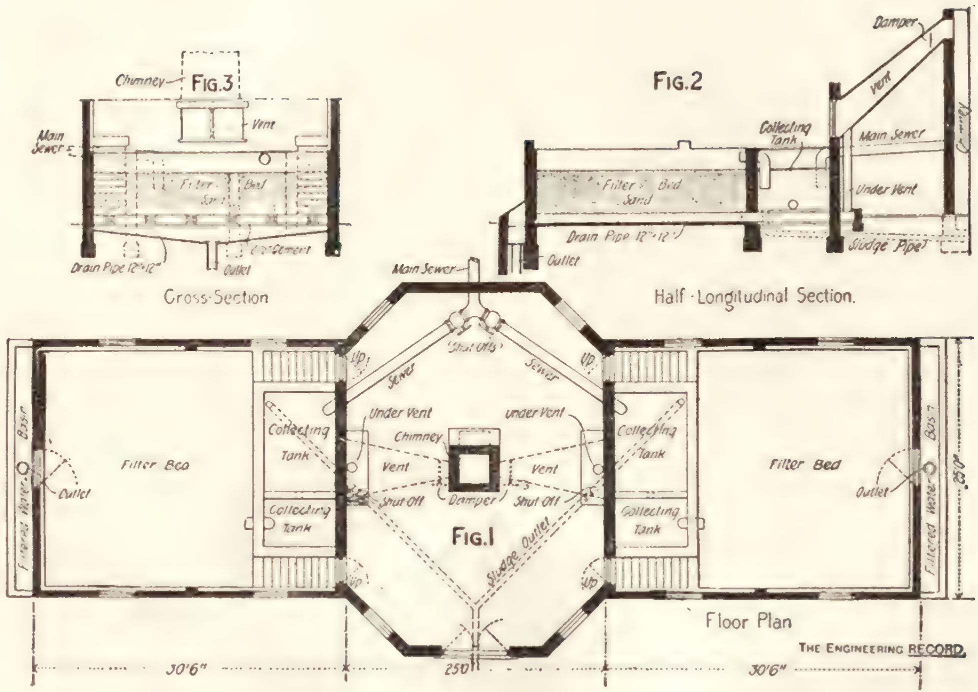
They are prepared to undertake the disposal of sewage for New York, Boston, Philadelphia, Chicago, New Orleans, or of any smaller city or town or institution in this country or abroad. They enter the field to construct and own sewage works for a fixed sum paid per month, or per year, by the municipality, under bonds to produce a certain degree of purification, under an agreement by which the municipality may take possession of the plant for a sum agreed upon, or on equitable valuation. They propose to utilize the wasted wealth and manurial values of the sewage, to dispose of it as an article of commerce, or to use it for their own benefit in restoring the worn-out soil of the hillside farm, or the pine barren. They are prepared to obtain ten tons of fodder from an acre which now will not support a sheep.

As a matter of sentiment they propose to restore the river and brook from an open sewer to its pristine purity, and to make the lakes and ponds no longer cesspools, but a delight and a joy, from which the sewer sucker disappears and in which the trout and salmon will thrive.

They can save to the United States government the annual expenditure of many million dollars for dredging harbors: and render sweet and free from pollution such resorts as Crescent and Nantasket beaches, Coney Island and Long Branch.

# MODEL DISPOSAL WORKS.

The disposal works designed under the patents belonging to the Company consist of two, three, or more settling tanks, roofed over and ventilated; so arranged that the sewage may be received in any one tank and flow through any one or all of the others, or be diverted from any one or more of the tanks, while said tank or tanks may be drawn off and cleansed at the will of the operator; built of such size that they will hold the sewage to be disposed of from one to twenty-four hours; and provided, where sedimentation is insufficient, with appliances for injecting lime, alum, sulphate of iron or other ingredients, to produce chemical precipitation. The effluent from the settling tanks, from which has been removed by sedimentation or precipitation much of the suspended and dissolved organic and mineral matter, is received alternately in one of two or more tanks, more or less filled with substances like sand, loam, gravel, broken stone, dirt, ashes, cinders, bark, coke, coal, charcoal, burnt clay, chips, hay, straw, or any other material obtainable and available, which serves to arrest the impurities of the sewage in its passage through the tanks, and partially filtrates the sewage. The effluent from the first filter bed or tank is received in one or more collecting tanks, where it is allowed to accumulate until it reaches a certain level, when it is discharged automatically and intermittently by one or more siphons, or otherwise, upon more or less extended filter beds exposed to the atmosphere or covered by a roof, stone or brick arches, tiles or inverted wooden troughs, covered by loam, sand, earth, gravel, concrete, or other available material; said filter beds composed of from one to five feet in depth of filtering material like or unlike the substance used in the first filter, are provided with a series of underdrains which permit the collection and carrying off of the filtered effluent to some point where it will not

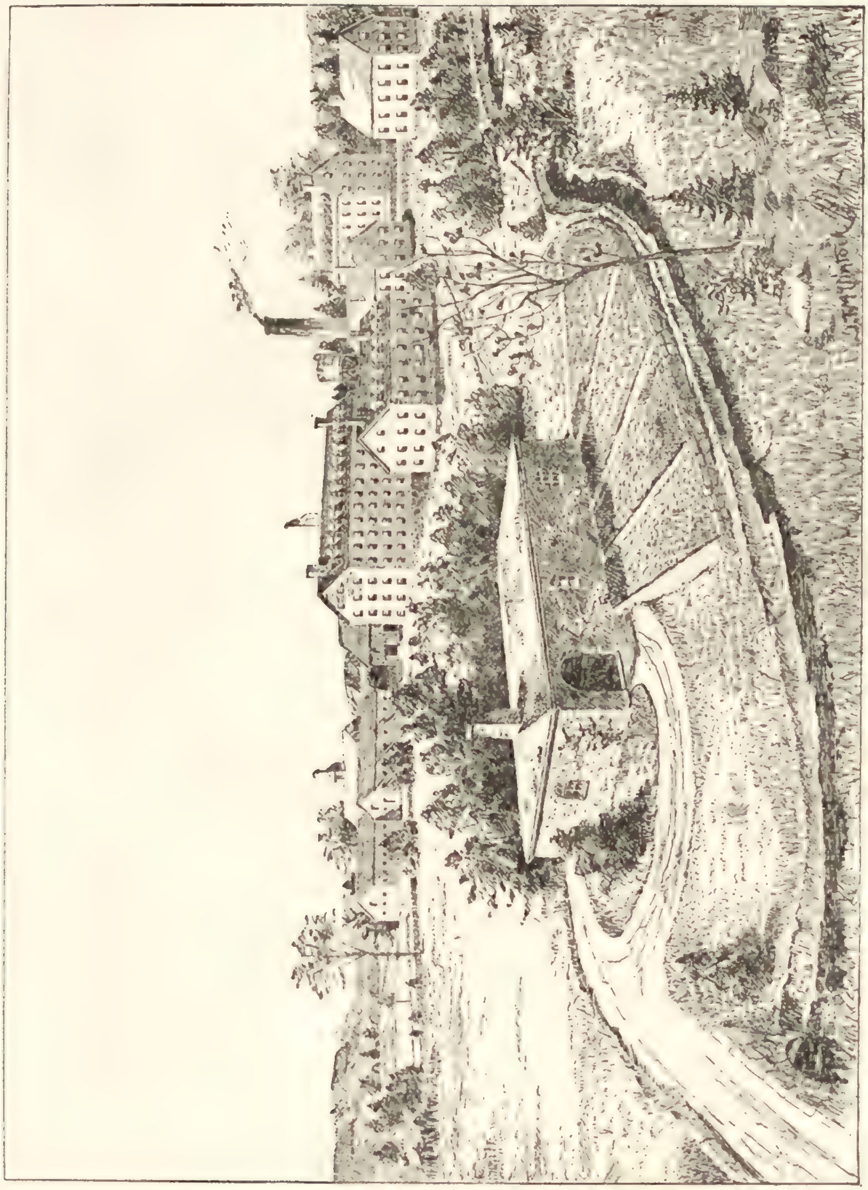



SEWAGE DISPOSAL WORKS DESIGNED FOR EXETER, N. H.

obstruct the working of the filter bed. When one of the first tanks is to be drawn off and sludge removed, it is disconnected with the flow of sewage, and its contents is allowed to settle or precipitate for a proper period, after which the tank is discharged by drawing from the surface and diverting the flow upon a sludge filter bed, which permits a passage through it of the partially clarified surface effluent, but holds the sludge, ninety per cent. of which is moisture, and permits it gradually to become separated, the water from the solid substances. For the care of extensive works mechanical appliances like sludge presses or rotary dryers may be used. The sludge may be cared for upon the premises or diverted elsewhere by pumping, gravity, carting, or other means of transportation. The settling tanks, first filter, discharging tank and sludge filter may be under the same roof or other covering, or any one or all may be exposed to the air as the locality demands. The proper ventilation of the covered tanks and filter beds is provided for by a natural or forced draft. The outside filter if covered by tiles, arches, or troughs, may also be ventilated.

As the Bell Telephone patents cover the conveying of sound by electricity, both of common knowledge, so the patents controlled by the American Sewage Disposal Company cover the treatment of sewage in a covered tank, and filter, both ventilated, and by filtration outside.

The first patent under which the company operates was issued in 1882, and covers the septic tank disposal system. The patent of chief service to the company was issued in 1896, and covers the septic tank in connection with inside and outside filtration. A model illustrating the practical working of the system under the patents was constructed for the authorities of Rockingham County, N. H., and has been in operation several years. An account and illustration of it was published in the *Engineering Record* in 1896.



THE BRENTWOOD, N. H. SEWAGE DISPOSAL WORKS.

# THE BRENTWOOD SEWAGE DISPOSAL WORKS.

The Sewage Disposal Works in Brentwood, N. H., constructed in the Fall of 1895, under the patents owned by the American Sewage Disposal Company of Boston, is in successful operation. Some changes, found necessary after construction in its operation, having been effected, it is a model.

The sewage of a large county establishment, before the plant was erected, was discharged into a small brook, and at times was equal to the volume of water of the brook before it received the sewage. The current of the brook was sluggish and meandered down the valley, across the highway, not "a thing of beauty," but an open sewer, and an offence and a source of danger for a long distance.

Two directors of the American Sewage Disposal Company of Boston recently visited and inspected the works. The Superintendent of the establishment, Mr. Henry Bean, accompanied them and stated that the septic tank had been in continuous operation for six weeks without any attention whatever. In the building there was a perceptible odor from the sludge filter, but over the septic tanks and the enclosed filter beds there was nothing offensive. The septic tank was doing its work, chemically, bacteriologically, and efficiently. It was purifying the sewage. The animal life was disposing of the organic impurities. The septic tank cultivates this animal life artificially. Countless millions of organisms are aggregated, battling, struggling, devouring, doing the brief duty assigned to them by the laws of nature, converting the organic impurities into harmless elements. The surface of the collected sewage in the tanks, protected only by the walls and roof of the building, was covered with a scum of fermentation, or bacteria, which seemed to absorb into itself the gases and effluvia given out under other conditions.

The effluent from the septic tank was received on four

carefully prepared coke filters, alternately. Here another law of nature, known in its application as intermittent downward filtration, provides for the oxydization and destruction of those very organisms so useful and important in the operation of the tanks. The effluent, as received on the surface, has lost almost entirely its character as sewage. It is slightly discolored, but not offensive.

Underdrains collect the almost absolutely pure water filtered through the coke, and discharge it from the building. The Superintendent stated that frequently people would smell, taste, and drink the water at this stage. From this point onward it has lost all perceptible appearance and character of sewage. The little brook which it joins runs merrily on, uncontaminated, to all intents and purposes.

The Superintendent states that the sewer sludge is composted with loam or ashes, and has more manurial value than the same bulk from the barns and stables. He has a large farm under his care, and has experimented with the sludge for several years.

The Brentwood plant illustrates the value of the patents owned by the Company. It was the first plant constructed, and in a certain sense was an experiment. There is a vast field for study and investigation in its operation and maintenance. The farmer, the chemist, the bacteriologist, the physician, the civil engineer, the university, the state, are deeply interested, for it has solved one of the most perplexing problems ever given to man, — the purification of sewage without giving offence, and the disposal of the sludge to the best advantage.

If the system will care for Brentwood, it will care for Chicago, for New Orleans, for Boston, for New York, or for any city or town in the world. The time is fast coming when it will be considered as absurd to dump sewage into the ocean, the lake, the river, or the brook, as great cargoes of grain or any food products.

The Brentwood Disposal Works, if rebuilt, would receive some minor changes in construction, which would add to their efficiency and facilitate the care of the sludge.

The septic tank at Brentwood holds about two hours' flow of sewage; the filters operated at first at the rate of 3,000,000 gallons per acre per day, this rate being reduced later to 1,500,000 gallons per acre per day.

# THE VALIDITY OF THE PATENTS.

The validity and originality of the patents is demonstrated by the adverse report made by the Massachusetts State Board of Health in October, 1895. The system was at that time unknown to the Board, familiar as they must have been with all methods of sewage disposal in use in any part of the world. The experimental station, maintained by the State for many years at Lawrence, had failed to make the important discovery of the working of the septic tank. When this was combined with rapid inside filtration, it was such an innovation that it was condemned by them. They refused to permit it to be inaugurated at Andover, although the Sewerage Committee of the town favored it, petitioned for it, and stated in their report to the town that it would effect a saving of $75,000.

The State demanded the method of discharging the crude sewage upon six acres of sand exposed to the air, which doubtlessly would purify the water filtering through it, but would pollute the atmosphere. Now that the works at Andover are constructed, and the superintendent finds that the effluent from an improperly built septic tank can be cared for and properly treated on two-fifths of an acre, the State authorities have inaugurated a series of experiments in rapid filtration from this same faulty septic tank. As their 1898 report has not been issued (October, 1899), their report concerning its operation may be looked for in 1901; in the meanwhile the septic tank is in full and successful operation in various countries of Europe and many States of the Union; and the original inventor, Mr. Amasa S. Glover, has gone to his last reward, his great discovery opposed to the last of his life.

# STORY OF THE PATENTS.

About 1880, Amasa S. Glover, of Brockton, discovered accidentally the principle of the Septic Tank. It was disclosed to him while caring for the drainage of his own residence. Being an observing and an intelligent man, he recognized its value, and applied for and obtained a patent in 1882, covering the principle. To apply the idea to the care of the sewage of a city, he employed an able civil engineer, and submitted, in 1886, a system for the sewage disposal of Brockton, which is described on page 11 of Report of the Massachusetts State Board of Health for 1388.

"Mr. Glover's original scheme, as far as it relates to the purification of sewage, consists of three principal parts:

"1. A settling-basin, which, without the aid of chemicals, is intended to separate and retain the solid portion of the sewage.

"2. A wall of gravel at one end of the settling-basin, through which the sewage is expected to filter.

"A series of arches of soft brick, over which the sewage is to flow, and through which it is intended to filter, then to drop through the space below, and so become aerated. From this space it is to run through drains to the stream.

"He proposes four divisions of this apparatus to allow for draining, etc. All of the apparatus is to be covered with a building having a central shaft or chimney for removing foul odors.

"Mr. Glover's scheme was referred to our engineer, who, after careful consideration of the method, and interviews with Mr. Glover, reports as follows:

"The scheme, as proposed, is thoroughly impracticable. The settling-basins would not cause the suspended matters to settle to a great extent, and the filters would not pass a sufficient volume at first, and would soon become clogged."

"Mr. Glover also presented an alternative scheme of a settling-basin and a sub-surface disposal on land."

In the light of modern research this report recalls the story of Galilei, who was forced, on bended knee, to disown his great astronomical discovery, at the command of church authorities.

During the years following, Mr. Glover approached the State authorities, from different directions, with the same general result. He was a persistent man, however. He knew that his scheme would work, and convinced one civil engineer after another that there was something behind it.

In the summer of 1895 Mr. Glover was introduced to the present manager and engineer of the American Sewage Disposal Company of Boston, whom he interested in the subject, and whom he regularly employed, for many months, to make an exhaustive study of the subject of sewage disposal, and incidentally, to become an expert in that line. By the engineer's advice, he took out the second patent covering the septic tank and rapid inside filtration and outside filtration, which added to the value of the system, as it made it simply perfect.

Unable to obtain permission from the State Board of Health to construct sewage disposal works within the Commonwealth of Massachusetts in accordance with his patents, Mr. Glover was forced to seek an opportunity to erect a working model of his system in the neighboring state of New Hampshire. Thus, by the expenditure of nearly or quite $2000 of his own money, and some labor and raw material furnished by the county authorities, he caused the now adopted Brentwood Disposal Works to be constructed, and had the satisfaction before his death of knowing that he had made a discovery which would benefit his fellow-men for coming centuries, although it is doubtful if he ever fully realized the value and importance of this discovery.

Mr. Glover did not understand the chemical and biological action in the tanks; he knew the results because he had experimented himself; with his own eyes he had seen the working of the septic tank, and proclaimed it to the world. It became an "Article of Faith" with him,—a creed. He died in 1897, and in due legal form the patents which he took out for sewage disposal eventually came into the possession of the American Sewage Disposal Company of Boston.

The officers of the corporation in advertising and commending this system to towns, cities, and institutions throughout the world, embark in the business with implicit faith, born of actual and absolute knowledge obtained from a working model on a scale large enough to demonstrate its feasibility under all conditions. They recognized the fact that though the underlying principles are correct, they require the services of an expert civil engineer to adapt them to the needs and demands of each community where they are adopted.

The patents go back so far that they are established in right and equity, and conflict with no previous patents issued to anybody. As might be expected, patents of such vast value have been, and will continue to be, imitated. It is needless to state that the American Sewage Disposal Company of Boston are acting under the best obtainable legal advice, and will maintain and defend their own rights and those of their patrons to the fullest extent.

# THE PURIFICATION OF DRINKING WATER.

The patents of the American Sewage Disposal Company of Boston apply as well to the purification of water to be used for a city or town as to sewage disposal. There is no necessity to longer endure the scourge of typhoid fever in any community. It is an enemy to be met openly and vanquished. However it originates, it is propagated principally by drinking water; and when that is purified the dread fever disappears.

The government of a city or town are elected to care for the well-being of the citizens. The health of a community is of the utmost importance. Now that it is known that it is possible to prevent typhoid and similar diseases, the city fathers should be held responsible for their outbreak in any community.

The American Sewage Disposal Company of Boston may be called upon for advice, consultation, or contracting, to render the water supply of any municipality as free from organic impurities as if distilled or drawn from an artesian well.

Settling tanks and rapid filtration would purify the water from any lake, river, or stream, more especially if it was slowly filtered afterwards intermittently through a good filtering material like coke, charcoal or sand. It is not safe to depend upon straining water through gravel only; for medical and health authorities recognize the fact that the germs so fatal to man can and do pass for a long distance by devious underground channels. It is asserted on high authority that many germs will not be destroyed even when subjected to temperature below the freezing point.

It is feasible to attend to the purification of water where gravity affords a water supply. Where it is necessary to use a pumping station, an additional hoist of from three to five feet will be all required for the operation of our system.

# SEPTIC TANK.

The septic tank sewage disposal system is accepted in England, where by law a certain degree of purification is demanded, as correct and efficient. An inspector of the Local Government Board recently said : "My Board does not refuse to sanction loans on these (septic tanks) systems. It is chary of sanctioning loans for any system which may be regarded as of an experimental character ; but after full and careful consideration with respect to this particular system before us, it has made up its mind to sanction loans for such schemes."

The works referred to, at Darfield, filter the effluent from the septic tanks at the rate of 425 gallons per square yard, or 2,000,000 gallons per acre.

The works at Barrhead, Scot., filter the effluent from septic tanks at the rate of 960,000 gallons per acre.

Septic tanks are in successful operation at Exeter, Eng. Besides the pioneer plant in the United States at Brentwood, N. H., erected in 1895, septic tanks have been successfully operated at Marion, Ia.; at Verona, N. J. ; at Urbana ; on a small scale at Chicago ; and at Champaign, Ill.

The last was planned by Prof. Arthur N. Talbot, of the University of Illinois, who reports: "From the results of these analyses it appears from 80 to 90 per cent. of the total organic matter, as represented by the albuminoid ammonia, by the oxygen consumed, and by the total organic nitrogen, is taken out. A still larger percentage of the organic matter in suspension is taken out. It may be said that these results are better than the results ordinarily obtained by the chemical precipitation process, and nearly as good as the winter results of some of the intermittent downward filtration processes.

"The effluent during the time this study has been made has been fairly clear, free from odor, and unobjectionable, a water chemically better than that of some of the shallow wells in this city.

"The effluent may be discharged into a small stream without objectionable results.

"In a trip east, a number of years ago, Mr. Noyes, who was city engineer of Newton, and later the metropolitan engineer of Boston, told me of a cesspool he had constructed for a public school building on this principle, which had worked successfully." These tanks were at first built "without any idea of bacterial purification of the sewage in the tank." "They were used to exclude the sludge." "But it was soon found that another action was going on."

Prof. Talbot makes but one error. It is in this statement: "This system may be used without infringing on any patents." An examination of the records of the Patent office at Washington will show the error.

The American Sewage Disposal Company of Boston is very desirous of establishing at least one experimental station under skilled supervision in every State of the Union, where investigations may be conducted exhaustively in this great field.

# BACTERIA.

Sir William Henry Preece, president Institute of Civil Engineers, in his address before the Sanitary Institute of Great Britain, at its Southampton meeting, in August, 1899, said: "The new biological treatment is a return to nature. 'Nature never yet betrayed the heart that loved her.' That wonderful micro-organism that has eluded man's observation for all these millions of years is divided into two classes, bacteria which work with oxygen, and those which do not. The sewage first reaches the settling tanks, where the inorganic matter, such as sand and grit, is deposited. The albuminous and organic matters and urea, which are found in all sewage, are there transformed by bacteria into forms of ammonia. The decomposition of animal and vegetable matter, which is invariably due to the action of these bacteria, is thus utilized to liquefy organic solids, and in this way to simplify their removal. Other bacteria, gradually, in special filters, transform the ammonia, by the aid of oxygen and other elements present, into nitrates. The process of filtering is intermittent, for air is essential to maintain the supply of oxygen to the nitrifying bacteria; but an air blast, in some cases, is used to maintain a continuous action. The nitrifying effect is enhanced if the air be warmed to about 100° F. The filters must have porosity and resistance to flow to retard the passage of the sewage through them, for time is essential for the bacteria to grow and to act. In sandy ground nature does this, but on clay formation, coke-breeze, and even coal, is found to be very effective. In this way bacteria first liquefy the solid matters in the sewage, and then nitrify them, simultaneously purifying and enriching the effluent, and preventing the formation of that wasteful product, sludge. Bacteria thus fulfil the highest function of the engineer, and nature asserts her power in fulfilling the

clearly-defined will of the Great Creator. The biological system has clearly come to stay. It is, however, still in the experimental stage. No great town has committed itself to its general use.

"Darwin was perhaps one of the first to point out how the lower animal life assisted nature by absorbing, as food, the decay of vegetation, digesting it and excreting it in the form of mold, and loam. His observation on the growth and functions of worms is not the least philosophical and scientific portion of his great labors. He probably attributed to worms much that is done by bacteria. Pasteur, the father of the germ theory, taught us how bacteria acted as nature's chemist. Koch, in Germany, has been a worthy disciple of Pasteur. The intermittent benefit of filtration was discovered, in the laboratory by Frankland in 1870. Warrington found in 1882 that sterilizing by boiling and antiseptic treatment stopped all nitrification. Aerating filters and the true action of bacteria were developed at Lawrence, in Massachusetts, from 1889 to 1893; Scott Moncrieff introduced his group of trickling cultivation beds in 1891; Dibdin commenced his experiments with filter beds shortly after; Cameron introduced his septic tank in Exeter in 1895; Ducal his continuous filtration process in 1897: and now, step by step, in Germany, France and England, we have reached a point where we can fairly say that sewage can be effectively treated with safety, simplicity and economy, by natural means."

History founded on the official records will give Glover the credit for discovering the septic tank, for his patent was taken out in 1882, and also for the added treatment of filtration, for he recommended it for Brockton in 1886. His patent for double filtration was taken out in 1895.

# SMALL DISPOSAL WORKS.

The discovery that is destined to become of such importance and value to cities and towns is equally applicable to detached institutions, State prisons, hospitals, asylums, jails, poor-houses, hotels on the mountains, in the valleys, by the seaside; colleges and seminaries, mansions, villas, and single farmhouses. The plant can be so constructed that it works automatically beneath the velvety sod, continuously, efficiently, and economically. It is the one indispensable thing that must be considered and planned for by the architect in all detached structures erected in the future, designed for human habitation, when comfort, health, and any degree of luxury is expected. It is second in importance only to a pure water supply. Its site should be chosen with as much care as that of the structure it is to benefit. The expense of this necessary work may be proportional to the cost of the structure it serves, to its permanency, or to economy in maintenance. Two per cent. of the cost of separate buildings ought generally to provide disposal works for them of the best character. The expenditure would be diminished for temporary disposal works; and increased for those working automatically, and requiring attention only at very long intervals. They may be disguised or absolutely concealed.

They should be provided, if only to care for the drain from the kitchen sink; certainly, to care for the laundry and bathroom. They would be the foes of flies and mosquitoes; and banish and keep away from the lonely farmhouse many of those fearful scourges so fatal to old and young, so frequently devastating a school district and a neighborhood, and so erroneously ascribed to an all-wise Providence rather than to human carelessness, negligence, or ignorance.

## NEGLECT OF SEWAGE DISPOSAL.

There is one school district in New England wherein a century ago there were three hundred inhabitants, scattered over fertile farms, self-sustaining and prosperous, where the people were not only fed, but clothed, from the fruit, vegetables, meat, grain and wool raised there. The old red school-house at the cross roads sheltered seventy or more pupils formerly, whereas to-day there is not a school-child in the district, and only a few old people remain and obtain a scanty subsistence on the worn-out farms. There are doubtless hundreds of such districts scattered throughout New England and the Eastern States. The same soil is there as of old, and it can be restored to its former fertility by judicious treatment. If what is taken from the soil is replaced, in whatever form, its fertility is maintained indefinitely. There are farms in Italy and Syria which have been cropped for over two thousand years, which retain their fertility year after year, producing wonderful crops. The food of a town or city is furnished by the country farming districts near or far, and the waste of the town or city should be restored to the land. It must be done in the line of true political economy. Our territory is capable of sustaining countless millions with proper care; as it is now we are becoming crowded. The effect on land of sewer sludge, the solid matter in the sewage, has been demonstrated. In about eighteen months it disintegrates and becomes the most fertile loam, retaining its richness for many years, or until successive crops again exhaust the soil.

# COMMERCIAL ADVANTAGE OF DISPOSAL WORKS.

There is nothing that can be done by the citizens of a town or city which advertises it more as a desirable place for business or residence than scientifically constructed sewage disposal works. Good schools, good roads, good water, good railroad facilities, good hotels, good government, and good people are expected in every American city and in most American towns. Sewers soon become a necessity to every large aggregation of population. But sewage disposal works appeal to the imagination. They advertise a city as one in the van of progress.

Ealing, a suburb of London, took a leap into popularity and prominence as soon as the sewage disposal plant was established there. It became instantly the most thriving suburb of that metropolis. East Orange, N. J., became the most popular suburb of New York when the sewage disposal works were constructed in the town; and the village quickly doubled, trebled, and quadrupled in population and wealth, attracting the choicest kind of people. The town got such a start that eventually it outgrew its disposal works, and found it more economical to enter the Newark sewers than to enlarge the plant, land had become so valuable. Worcester, Mass., is famous for the enterprise of its citizens, the character of its manufactures, and the magnitude of its disposal system.

Gardner, Brockton, Andover, Marlboro, Framingham, and Natick, Mass., have sewage disposal systems: and the State of Massachusetts has taken the most advanced ground of any Commonwealth in the world in investigating and experimenting officially with sewage and sewage disposal; bacteria and chemical action; filtration and oxidization; in examination and purification of water; and in publishing their work in full in exhaustive reports, eagerly sought for by scientific men throughout the world.

# THE MAGNITUDE AND IMPORTANCE OF SEWAGE DISPOSAL.

This country seems just awakening to the importance of this subject. The great cities of Paris and Berlin have solved the problem of sewage disposal. The "tight little island" of England forbids the pollution of rivers and harbors; and a royal commission enforces the law. Only one state in the Union, Washington, has followed the example of England. The magnitude of the problem elsewhere may be known from the fact that more money has been expended in sewage disposal works in Great Britain within a quarter of a century than the national debt of the United States incurred in suppressing the Rebellion.

The opinion has been expressed by some writer of note that the fall of Rome and the decay of the Roman Empire was due not to the inroads of barbarians, but to the Cloaca or ancient great sewer of Rome, which poured into the Tiber and into the sea and lost the manurial value from a million farms, made a desert of most of the Mediterranean Coast, filled up the Roman harbor, and degenerated the Latin race.

An English writer of repute, a physician and a scientist, considers sewage disposal by water carriage, while a great convenience, almost a curse to modern civilization; for as sewers are commonly built, they lead to a serious drain on a community, the inception of new diseases, and the spread of contagion. On the other hand he advocates the scattering of the people from the cities to the country.

With proper sewage disposal the sewers become a blessing to any community.

# LOCATION OF DISPOSAL WORKS.

It is possible to treat sewage in a thickly settled section without creating a nuisance. As a matter of cost as well as sentiment it is usually advisable to carry it as far as possible from any human habitation. It is much better to treat it on the main business street of a town or city than to pollute the water front or the source of water supply of the community itself, or of a neighboring municipality. It is not only foolish but criminal to endanger the lives or health of human beings: even the cattle, the sheep, or the hog must be protected from contamination while milk or meat is an article of food.

Every community should, if possible, treat and purify its sewage within its own territory, so as not only to have absolute authority on the premises, but be spared the humiliation of having its dirty but necessary work thrust upon its neighbors. If no land is available within its boundaries it should be bought, annexed, or made.

Disposal works can be so designed, constructed, and operated that the land devoted to the purpose may be the most beautiful and attractive section of the town or city in which they are located. It may be made to equal a section of Central Park, Boston Common or Public Garden, Mount Auburn, or Forest Hills Cemetery. The necessary structures may be disguised as Assyrian, Egyptian, Grecian, or Roman edifices, or represent the castellated medieval Gothic fortress. The architect could readily design an appropriate exterior.

The experiments at Lawrence demonstrate that subsurface filtration works are feasible. The ground above, if not converted into a park or play-ground, could be devoted to municipal purposes, such as the storage of water and sewer-pipe, paving blocks, edge stones, machinery, carts, or lumber. The sludge could be forced through pipe lines to any locality.

# MANURIAL VALUE OF SEWAGE.

The manurial value of sewer sludge per individual per annum is variously estimated by different authorities from $1.62 to $5.00.

| | |
|---|---|
| Lawes and Way value it at | $2.11 |
| Voelcker values it at | 2.25 |
| Hofmann and Witt value it at | 2.94 |
| Thudichum values it at | 5.00 |

Macaire, Marcet, Mechi, and Voelcker analyze it and find it equal to, or to exceed in value, stable manure.

W. Santo Crimp an English authority writes: "There can be no question that sludge does possess some manurial value, and the experiments by Dr. Munro, by Colonel Jones, and by the author, show that it is of about the same value as farm-yard manure, weight for weight. Indeed Dr. Munro is inclined to think that when properly dried and pulverized, a manure may be produced from sewage sludge worth considerably more per ton than farm-yard manure."

Sludge, if buried a few inches under a covering of loam, ashes, sand or earth, in northern sections of the United States, being subjected to the rigors of one winter, will be thoroughly disintegrated, and become a very valuable fertilizer. It is best to treat it on a sandy or gravelly soil, where the moisture is more readily absorbed in the soil beneath.

Mr. John E. Smith, Superintendent of the Board of Public Works of Andover, Mass., has experimented with sewer sludge, and finds it produces wonderful fertility.

Mr. Henry Bean, Superintendent of the Rockingham County establishment at Brentwood, N. H., finds it of more value on the farm than stable manure.

# THE CHARACTER OF AMERICAN SEWAGE.

The following article from the *Boston Herald* may be read with profit:

The experiments at Lawrence have demonstrated that ordinary sewage from American cities contains 998 parts of pure water, one part of mineral matter, and one part of animal and vegetable matter, or organic matter. Sewage would become entirely purified if we could take out the two parts of mineral and organic matter and leave the 998 parts of pure water, but as the mineral matter is not generally objectionable, we are satisfied to call it purified if we succeed in taking out the one part of organic matter. If to the surface of a body of open sand an inch of sewage is applied, it is found one day later that the bottom particles go down about nine inches, the top particles remaining just below the surface. In this nine inches about two-thirds of the space is occupied by sand, one-ninth of the space is water, and about one-quarter is air. The sewage is suspended here in extremely thin layers, covering the particles of sand and stretching between some of the nearest particles, and intimately mingled with more than twice its volume of air. Upon covering the surface with sewage today, the sewage of yesterday and more of the air which is associated with it are pushed down, with more or less mixture, by the incoming sewage to the nine inches next below.

Sewage will average in 100,000 parts, of free ammonia, 2.68 parts; of albuminoid ammonia, .63 parts; of chlorine, 8.57 parts; of bacteria, 923,000 per cubic centimeter. After settling four hours in the tank it loses 18.2 per cent. of albuminoid ammonia, and 12 per cent. of bacteria, by sedimentation.

The amount of sludge in sewage varies, but unless care is taken any sewage will in time clog any ordinary filter. The sewage applied to the experimental filters at Lawrence contains more sludge than the sewage of other places, and consequently the experimental filters require more attention to prevent clogging than do the several large filters in actual service at Framingham, Marlboro, Gardner and Westboro, which receive more dilute sewage.

# CONSULTATION AND ROYALTY.

The American Sewage Disposal Company of Boston does not seek to do all the business in the world or even in the United States in the line of sewer building or in the construction of sewage disposal works. It is aware that its patents dating back many years cover the most valuable, most reasonable, and most effective sewage disposal system ever devised by the ingenuity of man. It is no trust, trying to suppress competition; but enters legitimately the engineering and contracting field, welcoming intelligent and honest rivalry. It seeks the co-operation of engineers and contractors, and is willing for a reasonable royalty to share with any individual, firm, or municipality in any locality the benefits of its system. It is open to any negotiation looking towards the formation of a subordinate company having exclusive territory in some particular state of the Union, or some foreign country.

To organize such a company it is necessary for at least one civil engineer of good standing and one reliable contractor to unite their interests. The rights and interests of the parent company are so vitally involved with the success of a branch company that some care will be exercised in forming such companies.

The American Sewage Disposal Company of Boston, through its engineer, architect, counsellor, contractor, banker and broker, offers its services actively or in consultation, not only to municipalities, but to engineers and contractors on all matters pertaining to sewer designing; to sewer construction; to disposal works designed to partly purify and clarify sewage for admission into salt water, or to wholly purify sewage before it enters a source of water supply; to raising money for sewer construction; to apportioning the expense of construction; and to the many questions constantly arising in regard to sewers and sewage disposal systems. — *From Edition of 1899.*

# ADDENDA.

April, 1900.

We desire to call attention to the fact that it is possible to render pure water from the most polluted sources, such as sewage. It is possible to remove all impurities, and obtain an effluent, colorless, tasteless, odorless, free from bacteria and chemically pure. This result is obtained by taking advantage of natural laws, and applies not only to the purification of sewage before discharging into fresh or salt water, but also to ground, river and lake waters, which have been exposed to contamination, before they are used for domestic purposes.

Our company own the patents issued to the late Mr. Amasa S. Glover of Brockton, Mass., numbered 258744 (May 30, 1882) and 559522 (May 5, 1896). The first provides protection for the septic tank, which, if properly constructed, will remove 90 per cent. of the pollution while the sewage flows continuously through the tank. This is done by the so-called anaerobic bacteria, or germs of decay and putrefaction, which do their work of liquefying the solids of the sewage without the aid of oxygen. The last patent covers the filtration of the effluent from the septic tank. The first of the two filters of coarse material removes 90 per cent. of the impurities of the septic tank effluent, or 99 per cent. of the impurities of the original crude sewage. This first filter may be constructed as a contact bacteria bed, on the surface of which is applied a certain amount of the septic tank effluent until the bacteria bed becomes thoroughly saturated, when it is allowed to stand, and in one or more hours it discharges automatically by a siphon upon the second or intermittent filter. The second filter removes 90 per cent. of the impurities which escape from the bacteria beds, or 99.9 per cent. of the original impurities. The patents provide for the ventilation and covering of the tanks and filter beds. As the effluent from the first filter is colorless, odorless and tasteless, and remains for many months without further putrefaction, there need

be no cover or roof over the second filter. Our patents cover the principle and action of the septic tank in combination with filtration.

The septic tank may have a capacity of from twelve to twenty-four hours flow of sewage. The contact bacteria beds may have an area of one acre for a daily flow of 1,000,000 gallons, with a depth of five feet. The intermittent filter may have the area and depth of the bacteria bed. To obtain greater purification than 99.9 per cent. the intermittent filter may be enlarged.

Our latest automatic system provides mechanical arrangements for the drawing off of the septic tank and for the care and the disposal of the sludge; but as a matter of fact there is very little sludge if the separate system of sewers is used and surface drainage kept out of the sewers, the solid organic substances disappearing in the septic tank, and the filters acting efficiently for a very long time without attention.

The cost of constructing disposal works differs according to the locality. The tanks are simply concreted cesspools. Their shape is immaterial; they may be long, narrow and shallow. The filtering material may be in place or may be put in place. It is usually easier to bring filtering material to the sewage disposal works than to carry sewage to a natural filter-bed.

The bacteria of the contact beds and of the intermittent filter are called aerobic or nitrifying, and are dependent on the supply of fresh air for their continued effectiveness. The bacteria of the septic tank liquefy the solids of the sewage; the nitrifying bacteria convert the impurities in solution into their inorganic elements. The nitrifying bacteria are supported by the impurities from which they originate, and, having served their purpose, are oxidized by the air which passes through the filter to the underdrains.

The American Sewage Disposal Company of Boston have perfected a mechanical contrivance to divert the flow of sewage

automatically from one bacteria bed to another, thus giving one the chance to aerate while the second is in use.

By the septic tank we give 90 per cent. purification; by the septic tank and bacteria bed, 99 per cent.; by the septic tank, bacteria bed and intermittent filter, 99.9 per cent. or absolute purification, if necessary.

It is possible that your municipality or institution may be benefited by considering our system of sewage disposal, and our engineer would be pleased to confer with you as to the feasibility of your adopting it. It certainly can be constructed very economically; be maintained, if operated by gravity, at a very small expense, and will not be a source of discomfort or objection in any locality if properly built.

# LEGAL WARNING.

CHARLES H. DREW,
COUNSELLOR AT LAW,
1044 Tremont Building, 73 Tremont Street,
BOSTON.
Telephone: Haymarket, 1338.

BOSTON, March 22, 1900.

JOHN N. MCCLINTOCK, Esq., *President of the American Sewage Disposal Company of Boston.*

DEAR SIR: — At your request I have made a careful examination of the state of the art of sewage disposal with reference to the question whether the patent belonging to your company, granted to A. S. Glover, No. 559,522, dated May 5, 1896, is a valid patent. I have to say that I am of the opinion that the said patent is valid, and the claim is one of such scope as to control the art so far as it relates to the use of primary filter-beds in connection with settling or septic tanks, and in which provision is made for the removal of gases and in combination with secondary filter-beds, the contents of the latter of which are to be acted upon by the open air.

I am also of the opinion that the roof, such as is shown in Figs. 1 and 2 of said patent, or any structure over the primary filter-beds, is not an essential part of the invention described in said patent, and secured thereby; and that, in my opinion, any arrangement of filter-beds whereby the material to be acted upon is first placed in primary filter-beds, provision being made for the removal of gases therefrom, with secondary beds so arranged with reference to the primary beds as to receive the effluent by gravitation, which effluent is discharged from the primary beds, wholly through filtering material, and so that the effluent may be acted upon by atmospheric air in the secondary beds, is within the claim of said patent, and if made, or used, by any person not authorized by your company, would be an infringement upon said patent.

Yours truly,

CHAS. H. DREW.


RUSSELL PARK
PITTSFIELD : MASSACHUSETTS
June 1 1900
by
John N. McClintock of Boston
Engineer
Peirson
Ave.
Pomeroy
Noble
RIVER
HOUSATONIC
Scale of Feet
100 50 0 100 200 300 400 500
Drawn by John T McClintock

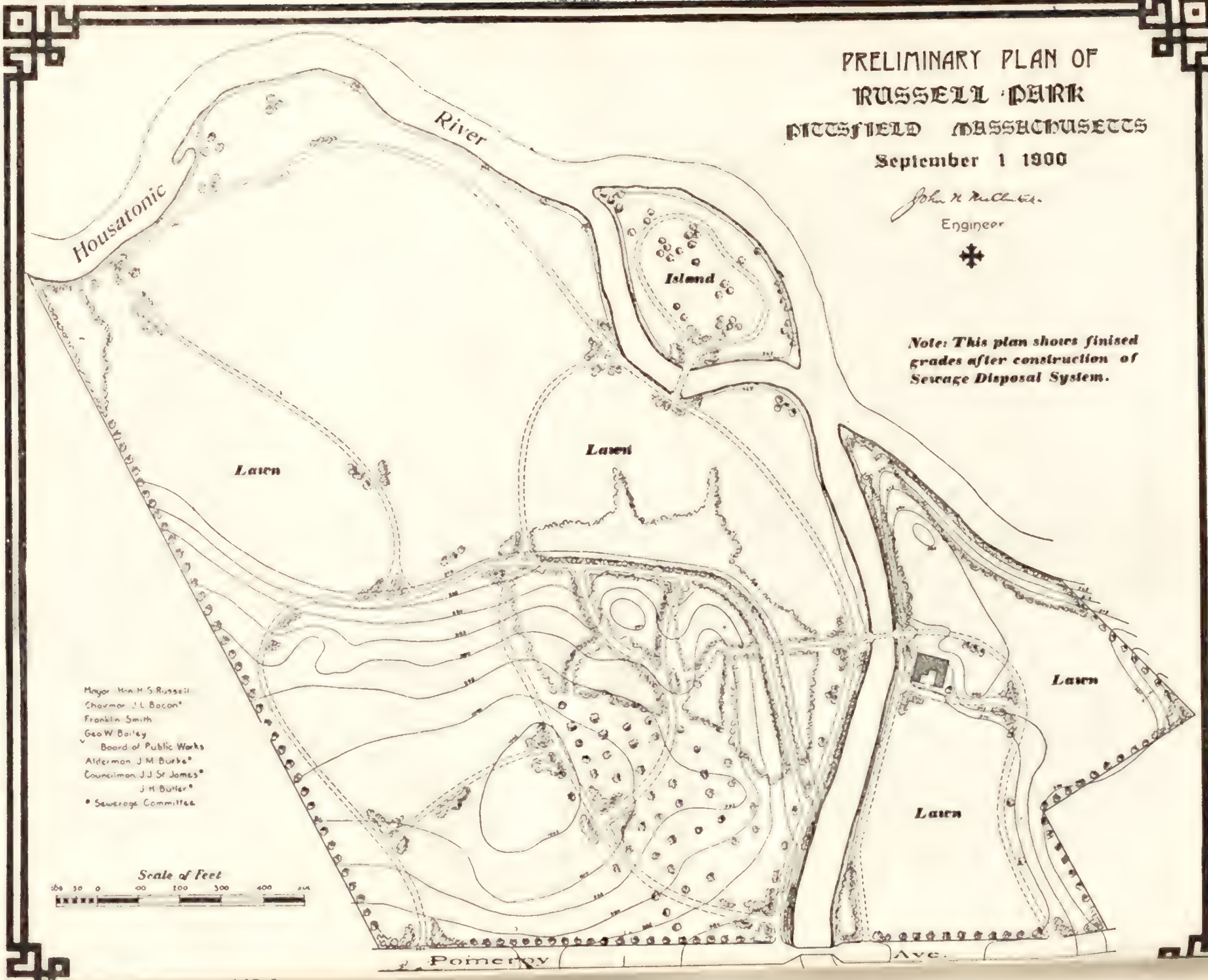

Sewage Disposal Plant in
Russell
Park

# PITTSFIELD.

In the summer of 1900 the American Sewage Disposal Company of Boston, at the request of Hon. H. S. Russell, mayor of Pittsfield, caused the necessary surveys to be made of a tract of land that had been selected by the proper authorities for sewage disposal, and proposed to build a pumping station, a covered reservoir for night flow, two or more septic tanks capable of holding two-thirds of the daily flow of sewage, contact bacterial filters 5 feet in depth of cinders or like material occupying three acres, automatic in action and protected by a covering of sod, and secondary filters of coarse sand covered in like manner, at a cost to the city of $100,000, at the same time providing the city with a park of 90 acres, beneath the surface of which nature would operate to convert offensive matter in the sewage into its inorganic elements. The accompanying plans and sketch illustrate more fully the conditions before and after the works were constructed. It was finally decided to locate the filter-beds at a greater distance from the residential part of the city, and the park idea was in part abandoned, except about the reservoir and septic tanks.

The system as a whole is doing satisfactory and efficient work, and it may be decided to illustrate the American System of Sewage Disposal. As in the case of Brentwood, some minor changes may be advisable to increase the efficiency and permanency of the system.

Plan No. P-129.


PRELIMINARY PLAN OF
RUSSELL PARK
PITTSFIELD MASSACHUSETTS
September 1 1900
Engineer
Note: This plan shows finised grades after construction of Sewage Disposal System.
Housatonic River
Island
Lawn
Lawn
Lawn
Lawn
Lawn
Pomeroy Ave.
Mayor Hon H S Russell
Chairman J L Bacon*
Franklin Smith
Geo W Bailey
Board of Public Works
Alderman J M Burke*
Councilman J J St James*
J H Butler*
* Sewerage Committee
Scale of Feet
100 50 0 100 200 300 400 500

# ADDENDA.

[From the "Boston Globe," Saturday, Nov. 9, 1901.]

## SEWAGE TURNED INTO DRINKING WATER.

### Septic System of Bacterial Attack in Successful Demonstration on Johnson Place, Milton.

"Come out to Milton and I will show you how to make good drinking water from sewage," was the somewhat startling invitation given to a Globe man yesterday by John N. McClintock, the Boston civil engineer.

It should be stated at the outset that the transformation of sewage into water for appeasing thirst was not the ultimate object of the Milton demonstration. It was intended, rather, to illustrate how easily and inexpensively the great problem of sewage disposal can be solved on a man's own property, the originally offensive matter being converted into water as sparkling and almost as pure as that which bubbles from a mountain spring.

When such a feat can be accomplished, without the slightest accompanying odor, it would seem as if the day of the odorless garbage-burning plant and the smokeless locomotive could not be far distant.

While the system in which Mr. McClintock is interested has already been put to practical test elsewhere, this is the first time that it has been locally applied, with the various improvements that several years' study have suggested.

The system is founded on primary laws of nature, and has nothing to do with chemical action. It is what is known as the septic system, and is only the application of the germ principle to an ordinary feature of human existence.

Every element of organic matter is now known to have its particular germ relation, and it is to Amasa S. Glover of Brockton, who died in 1897, that credit is due for discovering that the organic matter in sewage may be destroyed by bacteria, under certain conditions, just as all other organic constituents may be destroyed by it.

The late A. S. Glover, who discovered that solid matter in sewage can be destroyed by fermentation, demonstrated that the solid matter in sewage can be practically eliminated by fermentation, which is merely another term for the action of bacteria.

Indeed, he carried his experiments so far that he proved the ability of these bacterial agents to consume within thirty days such a "tough proposition" as a leather boot, to say nothing of a rubber one.

The biological treatment may likewise be applied to the disposal of garbage, even bones, it is asserted, being made soluble within the thirty-day limit.

The septic process has been tried, with various adaptations, in this country and England, and while it has not yet been adopted by any great cities except Manchester, London and Birmingham, Eng., its promoters firmly believe that its universal adoption will be only a question of time.

The place selected for the first demonstration of the system near Boston is that of Samuel Johnson, on Randolph Avenue, Milton.

Mr. Johnson, who has recently been remodelling an old house, was confronted with the problem of how to effectively dispose of the sewage from his residence without making its discharge offensive to himself and his neighbors.

There has been in successful operation on his property for the last two weeks an invisible sewage disposal plant, into one end of which the filthy output of the sewer pipe enters, which at

the other end is pumped from a gravel-lined well in the form of clear, sweet-smelling water. This, while intended rather for irrigation and domestic uses, is fearlessly drunk by people about the premises, and tastes like ordinary Cochituate. Several of the workmen drank it in the presence of the writer yesterday, and Mr. McClintock did not hesitate to take a dose of his own medicine.

Divested of its scientific and technical detail, the disposal plant on the Johnson estate consists of a series of cisterns or tanks, siphons and filtering beds, arranged so that the sewage will gently flow by gravity about 200 feet.

Practically everything connected with it is underground, so that its presence would scarcely be suspected, the only noticeable feature being an innocent-looking force pump at the end of the system, which, in lieu of a convenient brook into which to lead the effluent, is used to raise the latter to the surface.

After its emergence from the house the sewage is led through a ventilated trap into the first septic tank, 65 feet away. This tank, formerly an ordinary cistern, is about 5 feet deep and has a capacity of 500 gallons. The lower part of the tank is faced with stones, and has long been impervious to leakage, through the precipitation of sewage matter. In carrying out his ideas Mr. McClintock had the upper portion faced with brick and a heavy iron cover placed upon the manhole.

Two quarter-bends of pipe, connected in S or siphon form, lead from the upper part of the tank to the 100-foot line of Akron pipe that carries the sewage down to the second septic tank, but before these perform their functions the first tank has accomplished the most important part of the whole process.

In doing this it resolves itself into a sort of capacious "stomach" or digester, in which the organic matter in the sewage is attacked, after a certain lapse of time, by millions of anaerobic bacteria, or germs of disintegration and putrefaction, that shortly begin to grow and multiply in the tank. The matter on

which they live seems to give birth to this low form of vitality. It is a startling illustration of action and reaction.

The bacteria gather in the form of a thick scum; the number so contained in a square yard is incredibly large. At first they number about 1,000,000 to the cubic centimeter, increasing in the course of twelve or fifteen hours to 50,000,000. They thrive without oxygen, the cistern being practically air-tight, preventing the formation of dangerous gas. Sewer gas will not generate unless a certain amount of air space is provided.

The solid matter in the sewage, which is, of course, a small part of the whole, is seized upon by the omnivorous bacteria as soon as it has settled in the cistern, begins to undergo decay and finally becomes eliminated.

The first tank retains about 95 per cent. of the solid matter and about 90 per cent. of the dissolved impurities in addition, both of which come under the disintegrating influence of the bacteria. Bacterial action continues after the effluent from the first tank begins to run through the pipe connecting with the second septic tank, and after it reaches the latter. It has been demonstrated that this particular form of bacteria will find lodgment upon rock, gravel, brick and almost any inorganic substance except glass, which, apparently, presents too smooth a surface.

With the effluent that issues from the first tank, however, bacteria only to the number of about 150,000 to the cubic centimeter escape, and are then known as facultative bacteria. They grow beautifully less as the journey of the effluent lengthens, because the food on which they thrive has been taken from them, so that when the partly purified sewage reaches the primary filter the quantity is reduced to about 10,000 to the cubic centimeter. In this condition the sewage is in much the same condition of impurity as the water of the Merrimac River at the dam above Lawrence, just before it is sand-filtered for the use of the people of that city.

The second septic tank is of about the same capacity as the first. There the bacterial work is continued. A bottle of water was taken from this tank yesterday, and while it had a whitish, cloudy look, it was devoid of unpleasant odor.

The second tank is bricked, and, like the first one, has an iron cover. The liquid then runs into the filtering system, which is one of the most interesting features of the process. This is divided into two parts, primary and secondary, and bacterial action on the effluent practically ceases with the secondary filter.

A trench 15 feet long and $3\frac{1}{2}$ feet deep forms the basis. At its bottom is a layer of broken stone, surmounted by a layer of gravel, which is underdrained by an Akron pipe leading the filtered water into a siphon set a foot below the bed and made of the same piping. This system is fed by a pipe which enters the second tank near the top.

The secondary filter, reached through the siphon, consists of an air chamber of cobblestones, above which rests 3 feet of double screened gravel. An 8-inch Akron pipe runs from the surface of the ground into this air chamber, and by means of a force pump the purified water is raised.

Mr. McClintock estimates that one cubic yard of filtering space is sufficient for a single person. This system will carry on its functions indefinitely, as the bacterial action taking place at the other end of the underground "plant" effectively takes out all the elements that serve to clog the ordinary sand filter so quickly, making frequent cleanings and renewals necessary.

Fifty feet of filter space have been provided, with 15 cubic yards of filtering material in this instance, because 15 is the average number of persons expected to occupy the house.

Roughly speaking, two-thirds of the space allotted to such a system of sewage disposal will be taken up by the filters and one-third by the septic tanks.

If such a plant were to be constructed for the use of the metropolitan district of Boston, therefore, it would require about

1,500,000 cubic yards of space for tank and filter system combined. This could easily be found, Mr. McClintock contends, in the vast acreage of marsh land around Boston now going to waste.

While the Milton demonstration is proving what can be done for the disposal of the sewage of private residences, summer hotels and camps, where the interests of a comparatively few people are involved, Mr. McClintock is enthusiastic over the possibilities of the system for towns and cities.

"To a city like Boston," said he, "it solves a problem that some day may be serious, the filling of the harbor by the continued deposit of sewage sludge.

"Before the construction of the present main drainage system Boston harbor was being filled with sewage faster than docks and channels could be dredged. Even the present method of disposing of our sewage will in time result in filling up the harbor with a substance the most difficult of all to contend with.

"Bostonians are clamoring for a government appropriation for deepening and widening the harbor channels. They should not overlook the matter of keeping those channels clear.

"Think how many lives might have been saved in Tennessee during the war with Spain if some such system of sanitation had been in vogue at camps."

[From the "Boston Sunday Post," Nov. 10, 1901.]

## Sewer in Milton that turns Garbage into Drinking Water may revolutionize the World's Sewer Systems.

Out in Milton there is a plant for the disposal of garbage that is thought likely to revolutionize the sewer systems of America. [After a complete description of the works the article continues:] The plant was put in by John N. McClintock, A.M., C.E., who was formerly a member of the United States Coast Survey, and has for many years made a study of sewage disposal.

Experts who have examined the plant at Milton seem to agree that the plan as demonstrated there settles the sewer question that has vexed many city councils and countless boards of health.

It seems incredible that water twice removed from a cess-pool would be fit to drink, but by a system of filtration this remarkable feat is made possible.

Of course, as Mr. McClintock says in an interview with a "Sunday Post" reporter, water from a cess-pool is not for drinking purposes, — there is a strong sentiment against the practice, — but he points out that the main advantage lies in the fact that sewage can be converted into pure water, and therefore makes harmless any river or stream which is utilized to quench the thirst of a big city.

There has been in successful operation for some time an invisible sewage disposal plant, into one end of which the filthy output of the sewer pipe enters, while from the other end it is pumped into a gravel-lined well in the form of clear, sweet-smelling water. This, while intended rather for irrigation than for domestic uses, is fearlessly drunk by people about the premises and tastes like ordinary Cochituate. Several of the workmen drank it in the presence of the writer yesterday.

Practically everything connected with it is under ground, so

that its presence would scarcely be suspected. Mr. McClintock estimates that one cubic yard of filtering space is sufficient for a single person.

It is said that the flow of sewage into Boston harbor would fill the channel and make Boston an inland city in a thousand years and even in less time than that with an increased population. The black mud on the channel bottom, which has to be dredged out so often, is the sewage that empties into the harbor from all sides. That its contaminating influence is felt even beyond the harbor limit is shown by the poisoning of sea moss as far away as Scituate.

Oddly enough the principles of the septic tank for sewage disposal was discovered accidentally by the late Amasa S. Glover of Brockton in 1880. Being an observing and intelligent man he recognized its value and applied for and obtained a patent in 1882 covering the principle. As the working out of the principle has progressed and been put into actual operation, as demonstrated at Milton, more patents have been obtained to cover added features.

[From the "Boston Herald," Nov. 12, 1901.]

## How to avoid Typhoid.

*Practical Solution of the Sewage Problem. Septic Tank System has proved a Success. Example of the System on an Estate in Milton. Nature's Way of disposing of Sewage is Best.*

The recent mild flurry in typhoid fever has stirred public interest in two subjects, sewerage and drinking water. These two subjects bear a much more intimate relation to each other than is generally supposed. People do not knowingly drink sewage, as a rule, but that they do drink it, although quite unintentionally, is a fact to which every report of the State Board of Health bears testimony.

Polluted drinking water is not the cause of all the typhoid fever in the world, nor does every one who drinks polluted water have typhoid fever. But it will be safe to assert that, if sewage and potable water were kept apart, there would be less typhoid fever in the world.

A good example of the septic tank, or anaerobic system, is found on the estate of Samuel Johnson in Milton. It was installed by John N. McClintock, A.M., C.E. A "Boston Herald" reporter recently went to Milton to see the plant, and found it working satisfactorily. All the apparatus is under ground, there being no odor at all from the sewage. It is interesting to note that the water, after it has been purified, is caught in a well which has been built, and is raised to the surface by a force-pump. While the reporter was at Mr. Johnson's several of the workmen employed there drank water from the well with apparent relish. The water is clear and sparkling and tastes like ordinary well water. [Following a description of the works the article continues:]

In October, 1895, the "Boston Herald" called attention to the Glover (or American) system of sewage disposal. If it could accomplish what the inventor claimed then it would be of

great value to Boston as well as to any other city or town. If a cubic yard of gravel once properly disposed would prevent the annual deposit of a cubic yard of the most offensive black mud in the bottom of Boston harbor, a million cubic yards of gravel, properly deposited, would arrest a million cubic yards of mud from settling in the harbor every year.

The little plant now in operation in Milton shows the practical working of Mr. Glover's idea, which has been experimented with or copied in some of its features in other places. In London, Manchester and elsewhere in Europe the septic system in caring for sewage has been tried with great success. Nature does the whole work of purification. The engineer has simply to put properly in place the brick, rock, gravel, sand and drain-pipe. The whole forms an organism, of a low order it is true, but endowed with life. Its digestive functions are enormous, for it will assimilate all matter of animal or vegetable origin.

S. H. Adams, an English engineer now in this country, says that the septic tank plant has been operated very largely in England, and that nature, acting through its bacteria, can dispose of sewage better than can man.

[From the "Boston Traveler," Nov. 11, 1901.]

## New System of Sewage Disposal.

A means has been found whereby sewage and any water that has become polluted may be rendered almost pure. After passing through this process, which is nature's own, all impurities are removed, and the water comes out colorless, tasteless, odorless and free from bacteria. [Following a description of the Milton plant the articles continues:] All the sewage from the house of Mr. Johnson is treated by this system and comes out as clear as crystal. Mr. McClintock put the scheme into actual use, but the plans originated in the mind of the late Amasa S. Glover of Brockton.

Nothing but nature's own resources are used. A "Traveler" man viewed the plant and saw that it was in perfect working order. The arrangement is such that it can be introduced into any city or town and placed under a public park without any annoyance. The plant is constructed under two patents. The first calls for the construction of the septic tank, which, if properly constructed, removes 90 per cent. of the pollution while the sewage flows. The last patent covers the filtration of the effluent from the septic tank. The first filter removes 90 per cent. of the impurities that escape from the septic tank, or 99 per cent. of the original crude sewage. The second filter removes 90 per cent. of the impurities taken from the first filter, or 99.9 per cent. of the original impurities. The effluent from the first filter is colorless, odorless and tasteless, and remains so for many months without further putrefaction.

## Sanitary Science and the Public Health.*

It is understood to-day that the *typhosus bacillus* originates only in a case of typhoid fever, and by various channels is carried to its fell work of breaking down the strong man and causing death. And the practical point to be remembered is that this dangerous bacillus flourishes under unsanitary conditions, and demands filth as its necessary soil for growth and propagation. Sewage, improperly cared for, furnishes the chief actuating cause of this most dreaded of diseases. Two illustrative cases may be briefly cited.

In the years 1890 and 1891 a very serious epidemic of typhoid fever broke out in Lowell and Lawrence, Mass., and assumed the proportions of an epidemic and finally of a scourge. The cause was not far to seek. The public water supply of Lowell and Lawrence was derived directly from the Merrimack, into which private and public drainage is poured. As might be expected, this resulted in typhoid cases in these two cities. The 1,500 cases of the disease in Lowell and Lawrence were directly traceable to the infection of the water supply in the two cities.

The other case is the remarkable epidemic of typhoid among students of Wesleyan University, Middletown, Conn., in 1894, so carefully investigated by Professor Conn of that university, and clearly demonstrates the danger of the spread of this disease from oysters, this very common article of food.

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* Extract from an address by David H. Judd, M.D., of Boston, delivered in Rochester, N. Y., in 1902.

# ADDENDA.

SEPTEMBER, 1903.

A joint committee from the Senate and House of the Massachusetts Legislature visited the Johnson estate in Milton in the summer of 1902, and found no evidence of sewage about the grounds, save what was pumped through a three-inch pipe from twelve feet beneath the surface of the garden in the form of water as clear as need be.

BOSTON, Sept. 21, 1903.

MR. JOHN N. MCCLINTOCK, C.E.

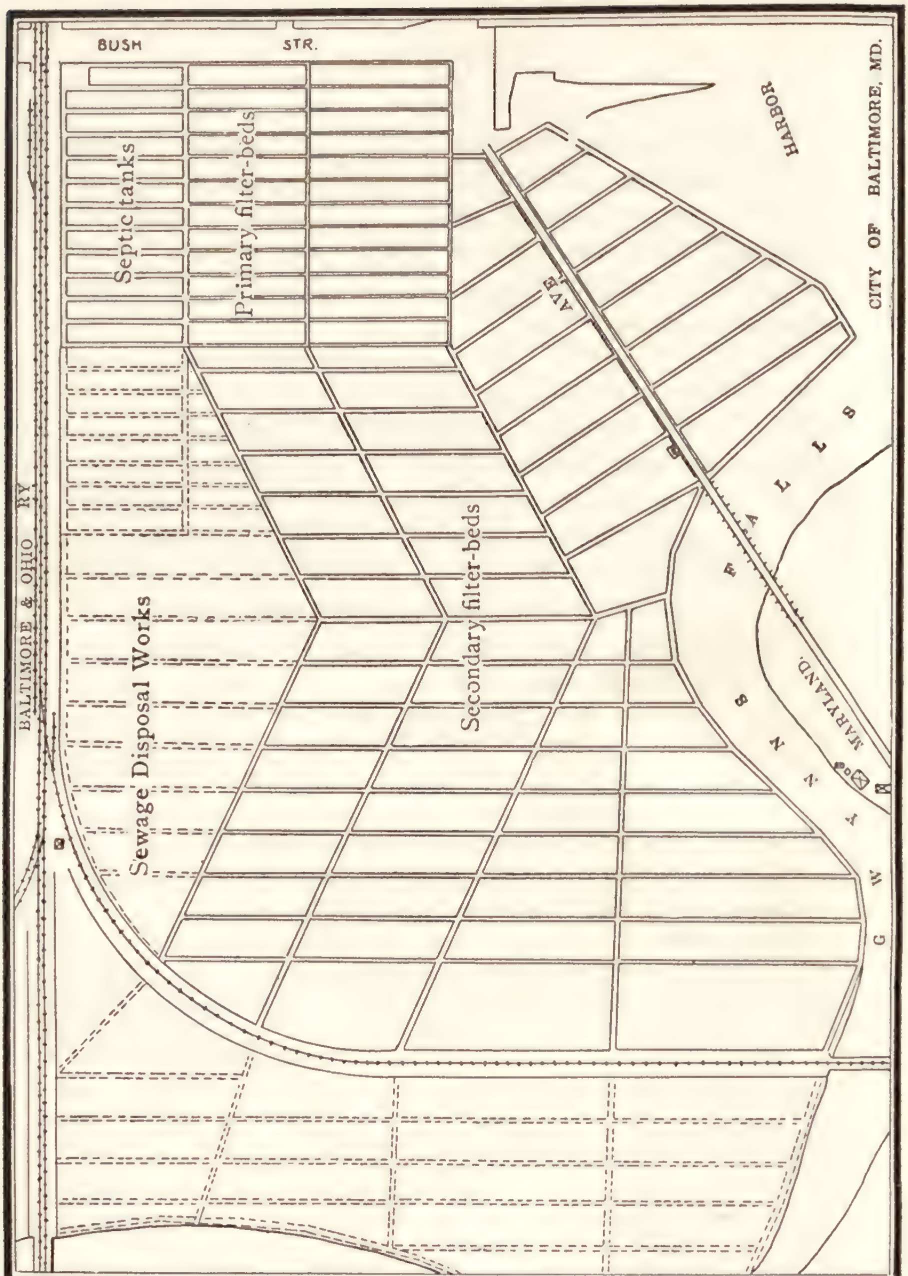
DEAR SIR: — You may be interested to know that the sewage disposal system which you built for me operated nearly two years without requiring any attention whatever. Recently the filters required overhauling on account of clogging from a continuous service of twenty months, but no solid matter of any considerable amount was found in either compartment of the septic tank, and none has ever been removed, to my knowledge, before or since the repairs.

Yours truly,

SAM'L JOHNSON.

[Had it not been for septic action within the septic tank during the two years the system has been in operation the tanks would have been filled five times with solid matter. — J. N. M.]

The report on the American System of Sewage Disposal, designed for the city of Baltimore, at the request of the mayor of Baltimore, may be found of value to other municipalities.


BUSH STR.
Septic tanks
Primary filter-beds
Secondary filter-beds
Sewage Disposal Works
BALTIMORE & OHIO RY
AVE
GWYNNS FALLS
MARYLAND
HARBOR
CITY OF BALTIMORE, MD.

# REPORT

TO THE

# MAYOR OF BALTIMORE,

On the American System of Sewage Disposal, made by John N. McClintock, President and General Manager, American Sewage Disposal Company of Boston, 1903.

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*To His Honor the Mayor of Baltimore.*

Sir:—I have the honor to submit for your consideration a report and accompanying plans as to the adaptability to the needs of Baltimore of the American System of Sewage Disposal, based upon the elaborate topographical survey of the city and the reports of the sewerage commission published in 1897 and 1899.

The American System of Sewage Disposal (invented by an American), embracing septic-action filter-beds retaining the sewage for liquefaction, provision for the gases resulting therefrom and secondary filter-beds, makes it possible for Baltimore to inoffensively purify the sewage of the city within its own territory, and to discharge such an effluent into the harbor as cannot injure the fishing or oyster industry, or leave any deposit in the harbor.

In considering its adoption, various problems arise.

The first problem is whether the surface drains are to be used to carry sewage, or whether sewage is to be carried by a new and entirely distinct system, not receiving ground water or surface drainage. The engineers who have advised the city favor the separate system, and it is the safest on many accounts.

The second problem is to determine what proportion of all the water, both rainfall and water supply, reaching the city will reach the disposal works in the form of sewage, assuming the use of the separate system, and a present water supply through

the mains of 50,000,000 gallons per day, slowly but surely increasing with the growth of the city and the improvement of conditions afforded by the sewerage system.

While the water supply of the city amounts to about 100 gallons per capita per day, the rainfall in the thickly settled section, if it were evenly distributed throughout the year, would amount to 40 gallons per capita per day, making a total of 140 gallons per capita per day to care for. When the new separate sewerage system is built, to receive only sewage, Baltimore will still have very generally covering the city the surface drainage system, which should receive all the rain water, all the ground water, all the water used in street sprinkling, on the lawn, in the garden, from hydrant and sill-cock, the overflow from watering troughs and public drinking fountains, the waste water from motor, elevator and from other sources, and all unpolluted water.

My estimate, under the above-named conditions, is that less than three-fourths of the water supply arriving through the mains need ever reach the sewage sewers of the separate system; that, therefore, with the present water supply of 50,000,000 gallons, provision need be made for only 36,000,000 gallons of sewage daily; and an average of 60 gallons of sewage per capita for the total number of inhabitants of the districts served by the separate sewerage system is an ample allowance and may never be exceeded. And, should the city not adopt the policy above referred to, but permit the entire 100 gallons per capita per day to reach the sewage sewers, since the organic pollution is not thereby increased, the size of the disposal plant probably need be increased little if any on this account.

The third problem to be settled is the location of the sewage disposal works. This problem involves the cost of the land to be utilized for disposal purposes, the character of adjacent property, the expense of bringing the sewage to the works and the disposal of the purified effluent.

It is possible by the American System to inoffensively purify the sewage of Baltimore in Druid Hill Park; but the expense of raising it to the proper elevation would be like that involved by carrying it to Glen Bournie, in Anne Arundel County. As it is desirable to locate the sewage disposal works within the jurisdiction of the city, and at as low an elevation as possible, in order to save expense of carriage and pumping, a study of the topography of the city suggests a tract of land bounded by Bush Street, the land of the Baltimore & Ohio Railroad, Gwynn's Falls and the harbor, comprising about 90 acres, as available for the purification of sewage by the American System. The survey indicates that a large part of this territory is marsh, and on account of its character must have a low value; there is more land in the neighborhood that may be secured for the extension of the works in the future; Gwynn's Falls, a stream of fresh water, is available to receive the effluent near the harbor; and the topography of the city permits the sewage to be delivered by gravity at this territory at a sufficient elevation to be treated from all sections, save the low-lying districts near the docks, the sewage from which section will have to be pumped in any event in order to be treated.

The fourth problem to be settled by the city is the system of sewage disposal to be adopted. There are four systems only that can be considered.

*Dilution*, or discharging sewage untreated into the salt water of the harbor, at the point selected, is too manifestly objectionable to be even discussed; while dilution in the waters of Chesapeake Bay will cost at first, according to the 1899 report of the sewerage commission, $3,202,846 to care for a population of 220,000, and $198,172 yearly to maintain; and, with the sewers, for a population of 1,000,000 $10,153,331 to build, and $361,461 yearly to maintain; which funded at 4 per cent. a means an increase in cost of $9,036,525, or a total cost of $19,189,856, or a per capita cost of $19.19.

This system is objectionable for its cost, and because it injures the fish and oyster industry. Sewage consumes the oxygen in the water upon which the fish depend; fish confined in sewage-polluted water die; sewage discharged into a river drives away the game fish and poisons the oyster.

It is contrary to United States Statutes, enacted March 3, 1899, section 13, of the river and harbor bill, to discharge sewage save in a liquid form into any navigable water of the United States or into any tributary thereof. If the solid matter is taken from the sewage, it is absurd to carry the liquid so far; if the offensive matter in the sewage can be taken out inoffensively, there is no need to carry the sewage further than where it can be collected in one place for such treatment.

*Chemical precipitation* might be employed at the locality suggested but would not be satisfactory, because it would involve a large annual expense for chemicals and attendance; because it necessitates the care, removal and disposal of vast quantities of sludge of very little commercial value; and also because the effluent from the system would carry much pollution to the harbor. It has not been recommended by the sewerage commission or the consulting engineers, and need be no further discussed.

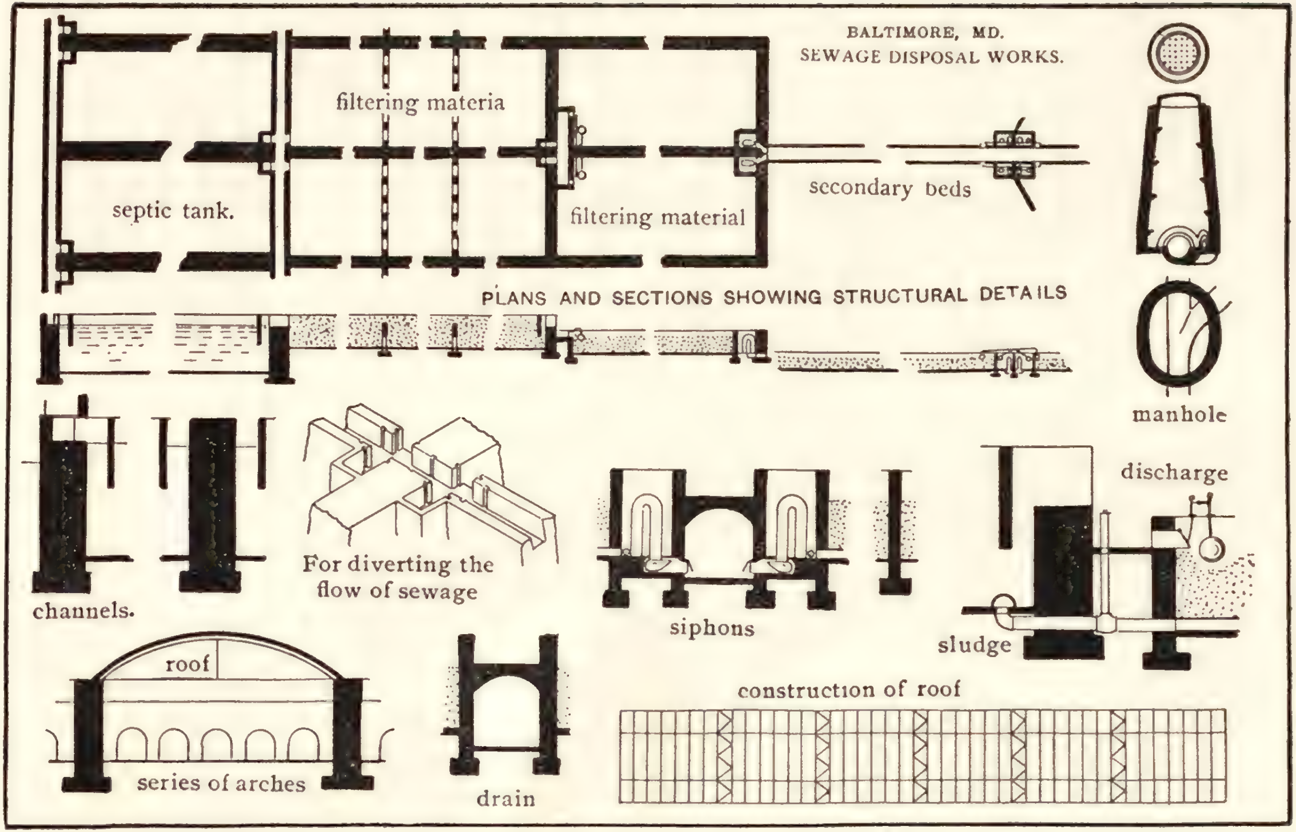
*Intermittent filtration*, broad irrigation or sewage farming is undoubtedly the best system of the three known to and considered by the sewerage commission and their expert advisers in 1897 to be adopted by the city of Baltimore, but it involves such a vast expense for machinery, pipe lines, land and maintenance, to make available such a small manurial value in the sewage, that it does not appeal to the judgment of the thoughtful taxpayer. The cost of this system with sewers is estimated by the sewerage commission in their 1899 report to be, when completed, for a population of 1,000,000, \$14,440,241; the annual cost of maintenance, \$781,683, representing at 4 per cent. an

additional cost of \$19,542,750; or a total cost of \$33,982,991; or a per capita tax of \$33.98; the number of acres enriched by the sewage, 5,384; and the income from the sale of crops, \$10,768; or merely enough to pay the interest on the cost of the land and the taxes.

*The American System* (invented by Amasa S. Glover) makes it possible to purify 50,000,000 gallons of sewage a day on 50 acres of land, and obtain as satisfactory an effluent as from 2,000 acres by intermittent filtration, or from 6,000 acres by sewage farming.

In a word it is this: a receptacle for the sewage in which the solid matters are liquefied and resolved into constituents, a part of which escapes in the form of volatile but very offensive gases, leaving a small amount of residuum, partly mineral, in the bottom of the receptacle; an enclosing structure with provision for said gases; secondary open-air filters upon which the liquid effluent flows from said first receptacle through such material, or means of discharge, as to hold back the solid matter and emit only the liquefied and partially purified effluent, whose purification is then completed by a process of oxidation and nitrification on said open-air filters.

The system is very simple, as illustrated by a description of the South Sewage Disposal Works, a plan of which I herewith submit and recommend for the location south of Bush Street and east of the Baltimore & Ohio Railroad. It consists of a primary filter-bed of any suitable construction and proportion, holding 1,536,000 gallons, or twelve hours' flow, roofed over and ventilated to dispose of the gases arising from the conversion of the solids into their constituent parts, and receiving the sewage by gravity or by pumping, through which tank the flow is continuous, at the rate of 3,072,000 gallons per twenty-four hours, and so constructed as to retain the solid sewage matter until liquefied and then permit the liquid to escape on to filtering


BALTIMORE, MD.
SEWAGE DISPOSAL WORKS.
filtering materia
septic tank.
filtering material
secondary beds
PLANS AND SECTIONS SHOWING STRUCTURAL DETAILS
manhole
channels.
For diverting the
flow of sewage
siphons
discharge
sludge
roof
series of arches
drain
construction of roof

material. This filtering material is shown as of half the capacity of the septic tank, and of the size of road metal. The flow of the liquid effluent through this filtering material is continuous; but it is so planned, in this instance, that it may act as an intermittent filter at the will of the superintendent. This is followed by about one-half as much more filtering material of a much finer character, through which the liquid effluent flows continuously, if desired, or intermittently. This whole structure is roofed over, and a chimney receives the offensive gases which are liberated by the bacterio-chemical action. These gases, as Mr. Glover suggested, may be easily burned, if desired, and their heat utilized. In any event their volatile character insures their dispersion through the chimney with absolutely *no* offence to the health or nostrils.

Thence the effluent, from which, by sedimentation, chemico-bacterial disintegration and liquefaction, the solids have been largely removed, is received into a channel, extending between a series of open-air secondary filter-beds, having gates permitting it to flow upon the surface of said open-air beds intermittently, and further means to draw the water from these secondary filter-beds into a discharge pipe leading to Gwynn's Falls.

The operation of the system in working order is as follows: the primary filter-bed, holding 1,536,000 gallons of septic sewage, will receive and care for 3,072,000 gallons of fresh sewage in twenty-four hours as its normal work; or it may receive 6,000,000 gallons of sewage occasionally in twenty-four hours without injury to the system. The sewage flows continuously through it; and being in a state of comparative rest in the tank clarifies itself of the heavier matters by their sedimentation, disintegration and liquefactions, and of some of the fatty matter by floating. The bacterio-chemical process known as "septic action" thus continuously liquefies the solids and disintegrates the dissolved organic matter. Only about 5 per cent. of the suspended matter escapes

as such, the remainder having been changed to a gaseous or a soluble condition; only about 15 per cent. of the bacteria escapes. The greater part of the suspended matter that escapes is nitrogenous, while the carbonaceous matter that clogs the ordinary filter is retained or liquefied. "Septic action" — in other words rot — is largely brought about here by the so-called anaerobic bacteria. The bacteria that give life to an out-of-door filter and make it operative are chiefly the aerobic or nitrifying bacteria.

Septic action may or may not be continued while the sewage passes through the first filtering material, according to the amount of previous septic action in relation to the amount of sewage.

The second and finer filtering material will be used as a contact bacteria bed, acting upon the effluent from the first filtering material by a class of aerobic bacteria that assimilates the organic matter brought in contact with them, thus largely eliminating it from the effluent. These two classes of filtering materials later on, perhaps, may be unified. The additional function for which they are here designed is to *insure* the prevention of the escape of any suspended matters on to the out-of-door secondary filter-beds which might clog them. Incidentally, this would also help to insure an effluent which could not injure fish or oysters. From the apparatus so far described escapes a clear and nearly odorless effluent.

A series of 12 such primary filter-beds, as is shown by the plan, would hold about 18,432,000 gallons, and would afford the proper septic action for a daily flow of 36,000,000 gallons, as previously herein estimated, or all the sewage from the present population of the city.

Finally, the 40 acres of open-air secondary filter-beds will sufficiently purify the 36,000,000 gallons of the daily effluent of the primary filter-beds, and will have the capacity to purify a much greater amount.

To summarize the proposed process of disposing of the Baltimore sewage: it takes the crude sewage and divests it by "septic action," as the bacterio-chemical changes are named, of all offensive matter, and very largely of all impurities; and then, by nitrification and oxidation, completes the purification; so that what enters the works as sewage is therein converted back into its harmless elements; and what comes out of the works as an effluent is merely harmless water, — as harmless as the natural water of the harbor into which it would be discharged.

The American System of Sewage Disposal for the present population of the city can be constructed upon 50 acres of available land, which, when enlarged upon 100 acres available, will purify the sewage from a population of 1,000,000. It can be so operated as not to give offence in the immediate neighborhood or elsewhere. It can be completed in a permanent and substantial manner for $1,500,000 for the present population, and enlarged pro rata. It can be made automatic in a large part of its operation, and so not be wholly dependent upon careless attendants. It will create no appreciable amount of refuse sludge to care for. It can be operated for many years without clogging the filters of the system. We confidently ask your city to adopt this system, not necessarily in the location that I have selected, or built in the precise form that I suggest, but *somewhere* and *somehow*, as the best engineering skill you may find available shall determine.

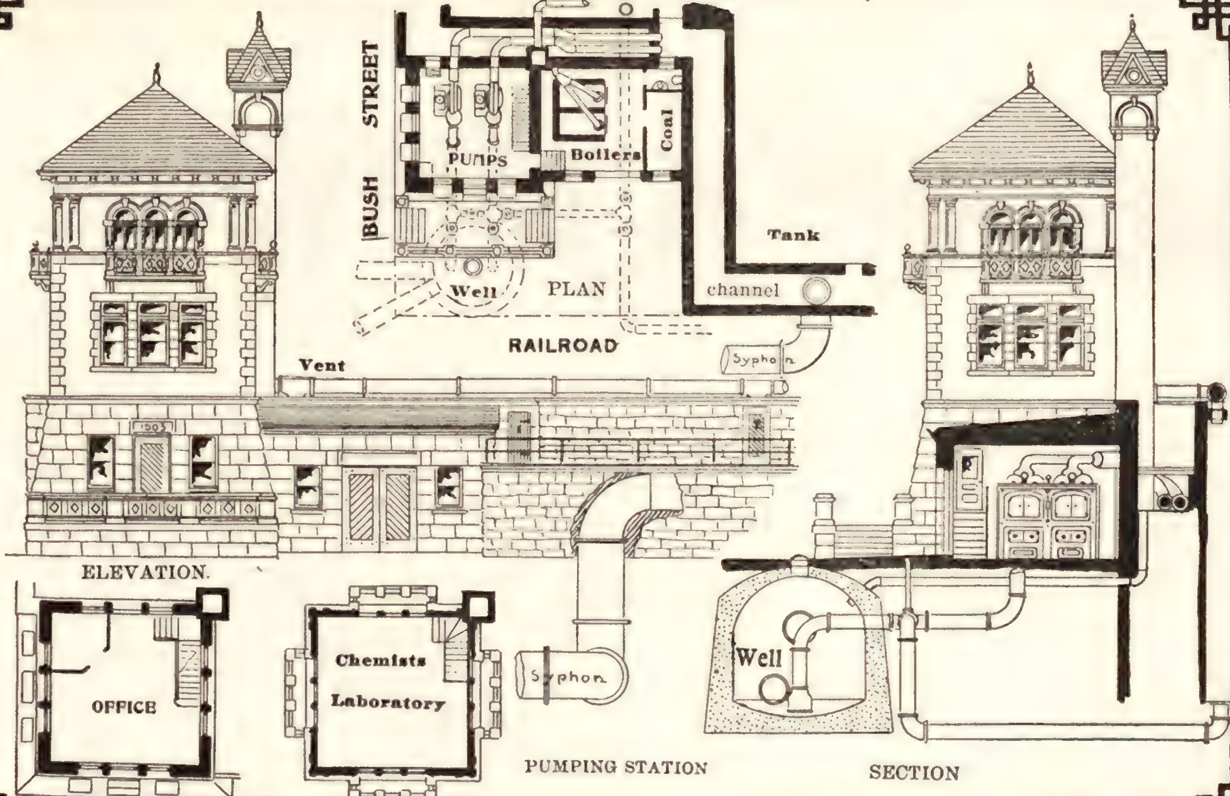
The fifth problem is a question of details. As the solution of this problem depends largely upon a settlement of the foregoing problems, I will assume that for a number of years the sewage reaching the South Sewage Disposal Works, located at the point suggested near Bush Street, is collected by the separate sewerage system, amounts to 60 gallons per capita per day for the population served by the system, and that the American System of Sewage Disposal is adopted. The details of one unit

of this system may be as follows: a primary filter-bed, retaining the sewage for septic action, roofed over and ventilated, of masonry, concrete, iron, steel, expanded metal and concrete, or of any suitable construction, may be built, with its watertight bottom at grade 0.0, or low water, holding 1,536,000 gallons; filtering material in the form of a continuous contact bed, filled with broken stone, clinkers or any suitable material, the bottom of the filter at grade 10; additional filtering material in the form of a contact bacteria bed, with bottom at grade 9, filled with proper material; a siphon or other discharge, and a series of perhaps six out-of-door secondary filters, averaging in size one-half acre each, arranged on each side of the supply and outlet channel, filled with filtering material from which the dust and fine matter have been removed by screening, with their bottoms at grade 1.0 or higher. This apparatus would normally purify 3,000,000 gallons of sewage per day, as hereinbefore explained.

A 5-foot iron pipe (or, if preferred, two of equal capacity) laid in the form of an inverted siphon, extending from the primary filter to a point on Liberty and Howard streets at sewer grade 32, branching where necessary into pipes of reduced size, and leading to points in the different water-sheds of the city, presumably where the sewer grade is 35 or higher, could provide a current that would deliver all sewage to the primary filter from the higher levels of the city for many years.

After the construction of the first unit of the system, as aforesaid, and the laying of the inverted siphon and the construction of the district and lateral sewers, the proposed system is ready for use to the extent of this unit, and may be completed by adding the necessary number of units as fast or as slowly as desired.

Upon completion of the first unit, as above described, work should be commenced at once on a second unit; when that is completed, the third can be built; and so on, as needed.




American Sewage Disposal Company of Boston.

I have had designed a small power house, pumping station, office, laboratory and a ventilator for the primary filter-beds, combined in one structure. Here the small amount of sewage of the neighborhood, and all that can be brought by gravity which cannot enter the inverted siphon, may be pumped into the primary filter.

The sewage of the central district, that now drains into Jones Falls near North Avenue, may be purified at what is shown on the plans as the Central Sewage Disposal Works, or, as the sewage can be collected at grade 60, it is possible to carry it by gravity through an iron main built as an inverted siphon to one of the arms of the 5-foot inverted siphon, and thence flow to the South Sewage Disposal Works.

The sewage of the eastern section of the city above a certain grade can be delivered in a similar manner.

The sewage of the city along the harbor front can be collected by an intercepting sewer and carried to some point where might be built a pumping station to force the sewage of the east district to the South Sewage Disposal Works.

The sixth problem involved is the cost of the construction of the disposal works and the sewerage system connected therewith. In view of the fact that the lateral sewers have all to be built in any event, and that a number of years must elapse before they can be built, and that it is not necessary to build disposal works faster than they are required, it may be well to build two units of the disposal works, as above described, the first year, to provide for 100,000 of the population; and two units every following year, providing for 100,000 more of the inhabitants, until the city is wholly provided for.

Without definite knowledge as to the cost of the land and the price of labor and material in Baltimore, I estimate generally that each unit of the system can be built for $125,000; that twelve such units, caring for 600,000 people, can be built for

$1,500,000 in six years; that twenty such units, caring for 1,000,000, can be built for $2,500,000.

The cost of the district and lateral sewers has been estimated by the sewerage commission to be $2,032,500 for the present, and eventually $5,280,000.

The cost of the inverted siphon and intercepting sewers and force mains may be $1,500,000.

The cost of the pumping station at the disposal works, with the necessary machinery, may be $50,000.

The cost of the pumping station and machinery at the east district may be $100,000.

To summarize the above items, the cost of the American System of Sewage Disposal and the required sewers may be as follows: —

| | |
|---|---|
| For the present population of 600,000: — | |
| Twelve units of American System, at $125,000 each, | $1,500,000 |
| Siphons, force mains and intercepting sewers, . . | 1,500,000 |
| District and lateral sewers, . . . . . . | 2,033,500 |
| Pumping stations, . . . . . . . . | 150,000 |
| Yearly maintenance up to 1,000,000 population, $50,000 funded at 4 per cent., . . . . | 1,250,000 |
| Total for 600,000, . . . . . . | $6,433,500 |
| For future population of 1,000,000 add: — | |
| Eight units of American System, at $125,000 each, . | 1,000,000 |
| District and lateral sewers, . . . . . . | 3,246,500 |
| Total for 1,000,000, . . . . | $10,680,000 |

The seventh problem to settle definitely is whether the city will adopt the American System of Sewage Disposal.

The same system upon which the American Sewage Disposal Company of Boston holds the United States patents is in

successful operation in disposing of all or a part of the sewage of some of the largest English cities, — London, Manchester, Birmingham, Leeds and Exeter, — and is in use in several American cities.

This system, as such, has been approved by such eminent scientists and sanitarians as Mr. Fowler of Manchester and Dr. Rideal of London, State Chemist Clark, Professor Sedgwick and Professor Kinnicutt of Massachusetts, Professor Folwell of Pennsylvania, and Professor Talbot of Illinois.

This system is recognized as sound practice by such leading technical publications as the "Engineering News," "The Engineering Record" and the "Engineering Magazine," and by many medical journals.

The introduction of the system has been effected under the direction of leading civil and sanitary engineers in the places above referred to.

In short, *dilution* of the sewage by discharging it into Chesapeake Bay, aside from being dangerous and offensive, has been estimated by the sewerage commission to cost the city of Baltimore $10,153,331 to construct and $361,461 yearly to maintain; or a per capita tax of $19.19; and

*Chemical precipitation* has no friends or advocates; and

*Sewage farming*, or broad irrigation, has been estimated by the sewerage commission to cost $14,440,241 to construct and $781,688 annually to maintain; or a per capita tax of $33.98; and

The *American System*, demonstrated to be effective and inoffensive, can be built to care for the sewage of the present population of the city, including the sewers and appurtenances, for $5,183,500; and to care for the sewage of a population of 1,000,000 for $9,430,000; can be maintained for $50,000 per year, or a per capita tax of $10.68.

We ask you to accept the American System, which in no essential respect conflicts with the reports of the Baltimore sew-

erage commission, although it submits a better system and one which has been successfully tested since the date of the reports. At that time the advice therein given would have been generally regarded as the best that could have been offered, and the best even to-day if that report be so modified as to take cognizance of the wide and increasing adoption of the so-called "septic tank" system, which we consider to be the subject-matter of our patent rights. But the recent and rapid adoption of this system at home and in England is sufficient evidence that it possesses extraordinary advantages over any system previously used. Some of the claims which constitute our argument for the use of the American System are as follows (and in making the comparison we accept the cost of other systems as estimated by the sewerage commission and also this commission's estimate of the quantity of sewage to be provided for, which, however, as already explained, we think unnecessarily large): —

It occupies a smaller area than essential in irrigation or intermittent filtration, and so admits of a much greater choice of locality for purification.

The works are perfectly inoffensive, which cannot be said of the outlet of a sewer, or of the deposits caused by dilution for miles along the shore, or of a sewage farm.

It delivers to the river and bay a liquid comparatively pure and free from all objectionable bacteria, which neither dilution or chemical precipitation can possibly accomplish.

In consequence, it affords absolute protection to the oyster industry, and, furthermore, removes any possibility that bay oysters can spread typhoid fever germs received from the sewage.

It costs less to maintain than any of the other systems.

The first cost of a complete plant under the American System would be less than that of irrigation or intermittent filtration; and probably less, at least not more, than dilution in the harbor, which must be left out of the question; and certainly much less than dilution in the bay.

Immediate benefit may be obtained for a first expenditure of $1,000,000 (providing liberally for the essential siphons, force mains and sewers) and for each $125,000 additional; whereas, if dilution be adopted, no advantage could accrue from it until $3,800,000 had been spent upon the outfall and appurtenances; and if filtration be adopted, until approximately $3,000,000 had been spent.

The American Sewage Disposal Company of Boston ask a royalty under their patents of 10 per cent. of the cost of the disposal works as fast as built and 1 per cent. of that cost for every year for ten years. This includes the plans and report herewith submitted, and consultation, if desired, with our experts.

This royalty has been included in the estimate of the total cost of the disposal works hereinbefore made.

Very respectfully submitted by

JOHN N. McCLINTOCK,
*President and General Manager, American Sewage Disposal Company of Boston.*

# LETTER.

*To His Honor the Mayor of Baltimore.*

DEAR SIR: — In connection with the American Sewage Disposal Company report, I would like to personally call your attention to certain facts, advice and deductions that may be of interest.

CHESAPEAKE BAY AND ITS OYSTERS.

Oysters thrive best in an arm of the sea which receives a certain amount of fresh water; too much water, like a freshet, will often kill them; too little water will stunt them.

Chesapeake Bay is most favorably situated for their growth and cultivation on account of its depth, of the climate and of the body of fresh water supplied by the Susquehanna and other rivers. Science may not yet have demonstrated how the oxygen in the water is necessary for the existence of the fish, or how fresh water mixed with salt water is essential to the oyster, but both facts, if not of common knowledge, are well known to oystermen and fishermen. While the physicians are now protesting against making the oyster a medium for transmitting disease, I cannot advise the pollution of the fresh water that gives life to the oysters of Chesapeake Bay, by the sewage of Baltimore, laden with all manner of germs of putrefaction and frequently disease. What was permitted in the last century is repudiated to-day in the light of recent investigation.

There is no body of water in any part of the world where the conditions for the cultivation of the oyster are so favorable as in Chesapeake Bay; but these conditions may change.

Let me give you a reminiscence: In Isle au Breton Sound in 1870 there was not a tree in sight from the marsh shore; yet in certain creeks the utmost care had to be used while doing coast survey work to keep the boat from snagging on the stumps of a submerged cedar forest. These stumps would

quickly disappear by the action of marine life in salt water; but the fresh water from the Mississippi River, coming into these creeks through irrigation channels, killed what usually destroyed wood and preserved the stumps, perhaps for ages. On these submerged stumps there grew oysters, known in the New Orleans market as Cedar Bayou oysters, which were worth then $8 a barrel, while the common oysters brought $1.50. A ready sale was found for all that were offered. I have had those oysters opened in the creek and have eaten them fresh from the water when I had to cut the oyster into four parts to eat it raw; one would fill a saucer. The shells of some were nine inches long. Those oysters were dainty and delicious food and never to be forgotten; they recalled rich cream from clover-fed Jersey cattle, gilt-edged butter, and all sorts of nice things, and were as rich and as nice to eat as anything in the world. I was told then that no oysters compared with the Cedar Bayou oysters for size and delicacy except the Chesapeake Bay oyster, and in later years I confirmed the statement by personal observation.

The growth and delicacy of the Cedar Bayou oyster convinced me that oysters thrive best where they receive a considerable quantity of fresh water. I am unable to explain why oysters thrive best under the conditions offered in those Louisiana cedar bayous and in Chesapeake Bay, and grow to a phenomenal size and to great perfection as an article of food there, and very seldom elsewhere. I am led to ascribe the results to similar causes. If oysters are affected by fresh water it is reasonable to believe that if the water offered to them is polluted by sewage, the oyster will become polluted.

The sewage of Baltimore, discharged at the head of the bay where the fresh water of the Susquehanna enters it, would, in my opinion, have a tendency to pollute the oysters the whole length of the bay. It would be much better for the oyster to keep the sewage of the city (if it *must* enter tide-water) in the

tidal estuary of the Patapsco River, or in the harbor itself, than to discharge it into the bay.

Chesapeake Bay has an area of 2,500 square miles. It receives a dry-weather flow from the Susquehanna River of 41,000 cubic feet per second of fresh water. From a water-shed of 71,000 square miles the bay receives an average flow of 132,000 cubic feet per second of fresh water. During a year the fresh water from the Susquehanna at the rate of the dry-weather flow would amount to a depth of 18.48 feet over the entire bay, while the estimated amount from the whole water-shed during the same time would cover the salt water to a depth of 59.55 feet.

This addition of fresh water to the bay did not commence, however, with the year, but away back in the times when the glaciers began to disappear.

As there is only about sixteen inches of tide at the head of the bay, the ocean cannot intrude between the capes much fresh salt water, so to speak; and the result is the magnificent conditions for cultivating the oyster in Chesapeake Bay.

The tendency of fresh water is to float on the top of salt water. Fresh water will gradually force salt water down and out of sand to a great depth. If a sand bar were formed across the mouth of the bay above high water it would be only a question of time before the salt water was entirely crowded out of the bay, and it became Chesapeake Lake. It is a problem what becomes of the enormous quantity of fresh water that annually enters the bay. There is no gulf stream of fresh water running down the bay, so the inference is that it mingles with the salt water and greatly dilutes it.

That the towns and cities upon the Susquehanna River are polluting the water with their sewage is no reason or excuse for Baltimore polluting the bay. A great river has a tendency to purify itself by natural laws. Purification is hastened in fresh water and retarded in salt water. In time Pennsylvania will be

called upon to remove sewage from every brook and river in the State; and at some time the national government will strictly enforce the laws already enacted against pollution of rivers and harbors.

Dr. Sims Woodhead found, according to the sewerage commission, that crude sewage containing about a half million organisms per cubic centimeter, when inoculated into the filtered effluent of the septic tank (or water similar to that brought by the Susquehanna River to Chesapeake Bay) developed more than one thousand millions in five days.

It seems to me, therefore, that Baltimore must give up the scheme of an outfall sewer to the bay or the use of the bay oysters as a safe article of food.

## The Capacity of System.

The American System of Sewage Disposal is elastic in its functions, because, while the primary filter-beds, as described in the report, are best adapted to purify or filter 36,000,000 gallons of sewage in twenty-four hours, they will operate just as favorably if they receive a smaller amount; and, on the other hand, they will do good work if they receive a larger amount. Within proper limits, and with proper management, it seems that the American System is perpetual, — it cannot "wear out."

The secondary out-of-door filter-beds, adapted to purify 36,000,000 gallons of the effluent of the primary filter-beds, may be taxed for a considerably greater amount per acre per day if a proper effluent from the primary filter-beds.

If crude sewage, *i. e.*, not purified in the primary filters, were to be applied to the secondary filter-beds of 40 acres at the rate of 1,000,000 gallons a day, or 25,000 gallons per acre per day, the beds would only operate a few years before becoming clogged and useless, as has been demonstrated at Plainfield, N. J., and elsewhere.

of the sewage-purifying apparatus might well be entrusted by the city to men specially appointed, who have the necessary knowledge, who can be trusted, and who may reasonably expect retention in office. A superintendent should be a good executive, with ability and education enough to permit him to understand the operation of the various parts of this system, with faith in the system gained by investigation, and should command a salary upon which he can live with dignity. He will become the dean of Superintendents of Scientific Sewage Disposal Works in America, and rank in this country as do Mr. Fowler of Manchester and Dr. Rideal of London in Great Britain. A chemist is another important officer of the works.

It may be that ashes can be used in the construction. The fine ash obtained by sifting may be the proper material to form the foundation of the filters on the marsh, while the coal and clinkers may be found to withstand the action of water and bacteria in the filters; and the city, while disposing of its wastes in this manner, will effect a large saving in the cost of construction.

Granite and field stone can be used to face the walls of the septic tanks. There are certain kinds of rock that will not withstand septic action or the action of water, but will disintegrate and consolidate into strata; these must be avoided.

## Operation.

In operation the American System may be compared with a thing of life, and must be so fed; for it is life action that produces the results sought. The septic tank of the system is the stomach, that digests all organic matter brought to it by the sewers, and it must not be overworked. The filters may be likened to the lungs; and the alternate filling and discharging to respiration; for it produces a like effect of purifying the vital fluid of the system.

Although it takes a number of days or weeks for a septic tank or filter to become fully effective in its functions, it continues its action with slight attention.

The works are so designed that any tank or filter may be shut off from service for repairs without interfering with the operation of the system as a whole. Provision is not made for permitting the septic tank to be discharged directly into the harbor under any conditions. I have designed a pipe connection that will permit the contents of any tank that has been shut out of use to be pumped into the others of the series.

If for any reason it becomes necessary to shut off the flow of the septic sewage from the first filter, a pipe and gate are provided to permit the filter to be discharged through the underdrains of the second filter upon the surface of one of the secondary filters, that may be used as a so-called sludge filter. Each of the second filters can be thrown out of service.

By using more complicated and expensive construction than shown in the plans it would be possible, without an increase in the area utilized, to increase the efficiency of the Disposal Works to care for a population of 2,000,000 or more.

When the inverted siphon runs full it will be possible to avail of the power created. There is also a source of power, heat and light in the gas generated in the septic tank.

## Manurial Value.

According to investigating chemists there is a value in sewage of from $2 to $5 per capita per year; so Baltimore will send to the Disposal Works by a completed sewerage system values to the amount of over $2,000,000 per year. This value is carried by an enormous quantity of water, from which it must be separated to become available.

Some time in the future some investigator may discover how to separate the dissolved organic matter in the sewage from

the water, and recover it for commercial purposes at a profit, but the art is unknown to me.

With the suspended matter in the sewage the case is somewhat different. The sewerage system of Baltimore will carry to the Disposal Works annually more than 100,000 cubic yards of solid organic matter which may be disintegrated there. Perhaps one-half of the value of the sewage is in the suspended matter, that can be either burned up or in part recovered in the processes of the American System. The problem is the economical application to the land. Supposing its value to be $5 per ton, it certainly will not pay to carry 1,000 tons of water in which the ton is suspended any considerable distance; taken from the water, it is a question how far it would pay to transport the ton. If there should be a demand for it when the works are completed, the sewage may be all passed through one tank before reaching the others, with the result that septic action will be arrested, and the solid matters will accumulate until the tank is full; and the sludge may be pumped into oil tank cars, or into tanks on vessels, or through a 6-inch iron force main to Anne Arundel County, so that it can be shipped to a market when a market can be found for it. It becomes good fertilizing material in the course of from eighteen months to two years.

Sewage farming in America is poor economy unless in some arid region where the water is needed for irrigation.

## Sewers.

It is not necessary for me to advise Baltimore as to the size and grade and manner of construction of the sewers, outside of the Disposal Works. I beg to suggest that the sewers should be laid with water-tight joints, so that ground water may be excluded, and that where necessary underdrains be laid in connection with the sewers, to care for ground water, and to discharge into the surface drains or wherever practical. Such construc-

tion will greatly reduce the size of pipes required and lessen the expense of pumping.

It has been assumed that the surface drains of Baltimore receive no sewage directly but are restricted to rain water. It may be possible to admit the dry-weather flow of the surface drains to the new system by providing storm overflows through existing channels to the harbor, for the relief of certain districts, until some time in the future, when the lateral sewers are laid.

If what the surface drains carry at present does not cause offence, there can be no objection to this proceeding. It may be possible that in the past some sewage has found a way into the surface drains, so that the discharge needs purification; if so, it might be well to build the intercepting sewers to tap the surface drains for the dry-weather flow at as early a date as practicable.

## Connections.

Primarily the new system is to remove organic matter, and is especially adapted to dispose of domestic sewage. It is also adapted to care for the offensive organic wastes from most manufacturing works.

There are certain wastes, however, chiefly of inorganic matter, that should not be admitted in large quantities to sewers connecting with the American System of Sewage Disposal, as their chemical effects are to retard biological action in the primary or secondary filters, or cause the precipitation and collection in the system of suspended matter. Such substances as lime, copperas, sulphurets, acids and metallic salts interfere with the proper action of the system.

Wherever, within the district drained by the sewerage system, it becomes necessary to dispose of inorganic waste matter from manufacturing establishments which would interfere with biological action, special provision for purification or neutralization may be made, either by the parties interested or by the city.

## Medical Aspect.

Within recent years science has demonstrated that bacteria are the causes as well as the results of diseases. The great work started by Pasteur, continued by Koch and other scientists, of separating, cultivating and studying the various bacteria that cause specific diseases, with a view of eliminating them, has proven that many of them that are dangerous to the human race survive under conditions afforded by sewage. These include the bacteria of water-borne diseases.

When sewage, without purifying treatment, is discharged directly into either fresh or salt water, there must always be an element of doubt as to the ultimate mission of the disease germs that are thus scattered.

The American System of Sewage Disposal not only permits a sewerage system to be safely built in any city, but renders it advisable to have it built, for the reason that all manner of disease germs may be properly consigned to the sewers connecting with the system.

It is a well-established fact that disease germs do not originate, but are propagated from some antecedent case; therefore, to eliminate such diseases from a community, the germs from the known cases need to be destroyed.

Dr. Pickard* specially investigated the typhoid microbe. He concluded that the sewage itself was not only a bad food, but an actual poison to these bacteria; that in the septic tank they suffered a rapid destruction, and that the filter-beds effect a further biological elimination, so that there is no chance whatever of the filtered effluent causing typhoid fever if it passed into the river.

Respectfully submitted,

JOHN N. McCLINTOCK.

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* Second report of Sewerage Commission, page 13.

The Massachusetts State Board of Health, after long and exhaustive experiments, have recommended the system owned by the American Sewage Disposal Company of Boston to the towns of Andover, Hopedale and Clinton and to the cities of Brockton and Pittsfield, in each of which municipalities the system is in more or less successful operation.

The town of Hopedale has acknowledged the validity of the patents and received a license to operate from the company.

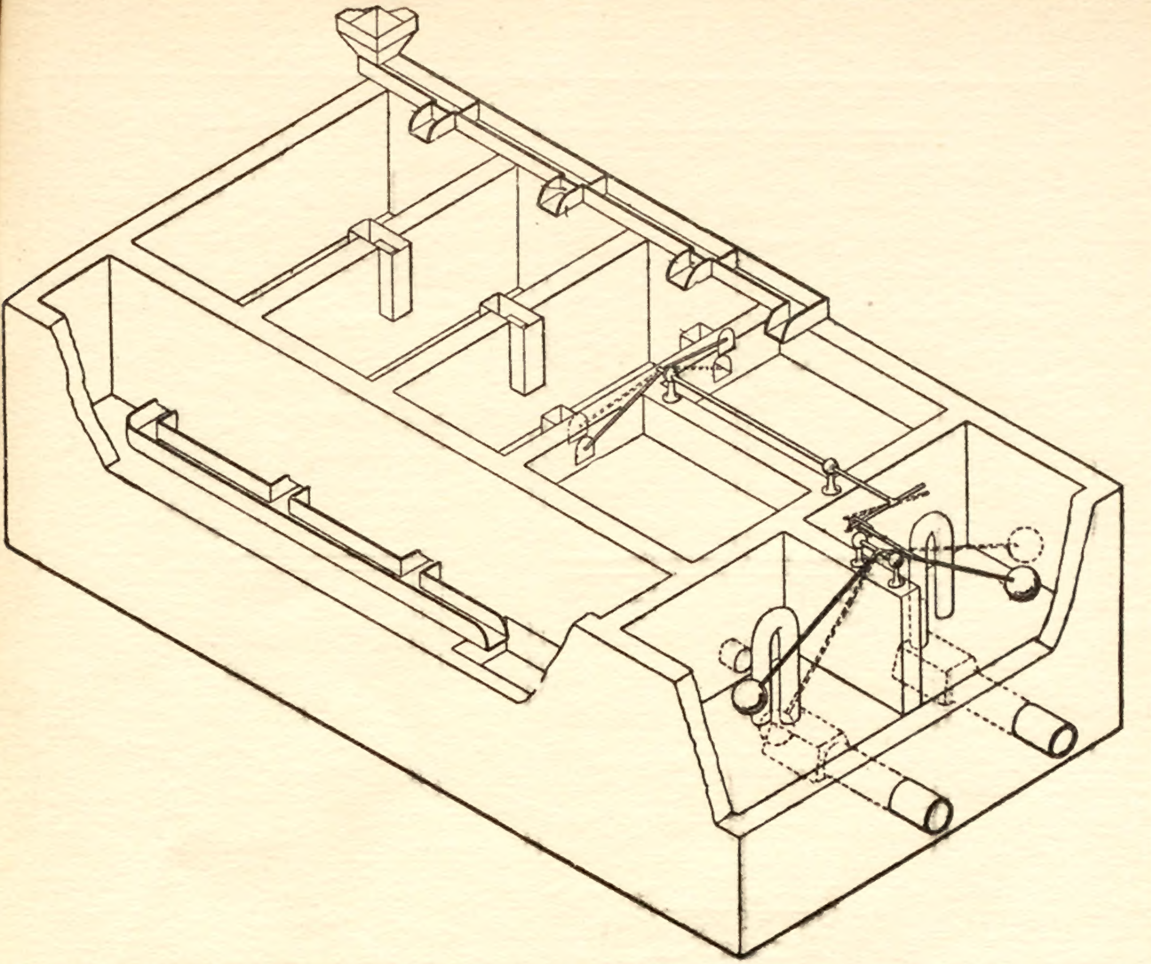
The model sewage disposal works at Liberty, Sullivan County, New York, are being operated under a license issued by the American Sewage Disposal Company of Boston.

From the "Engineering News" of April 2, 1903, page 302, is taken the following extract: —

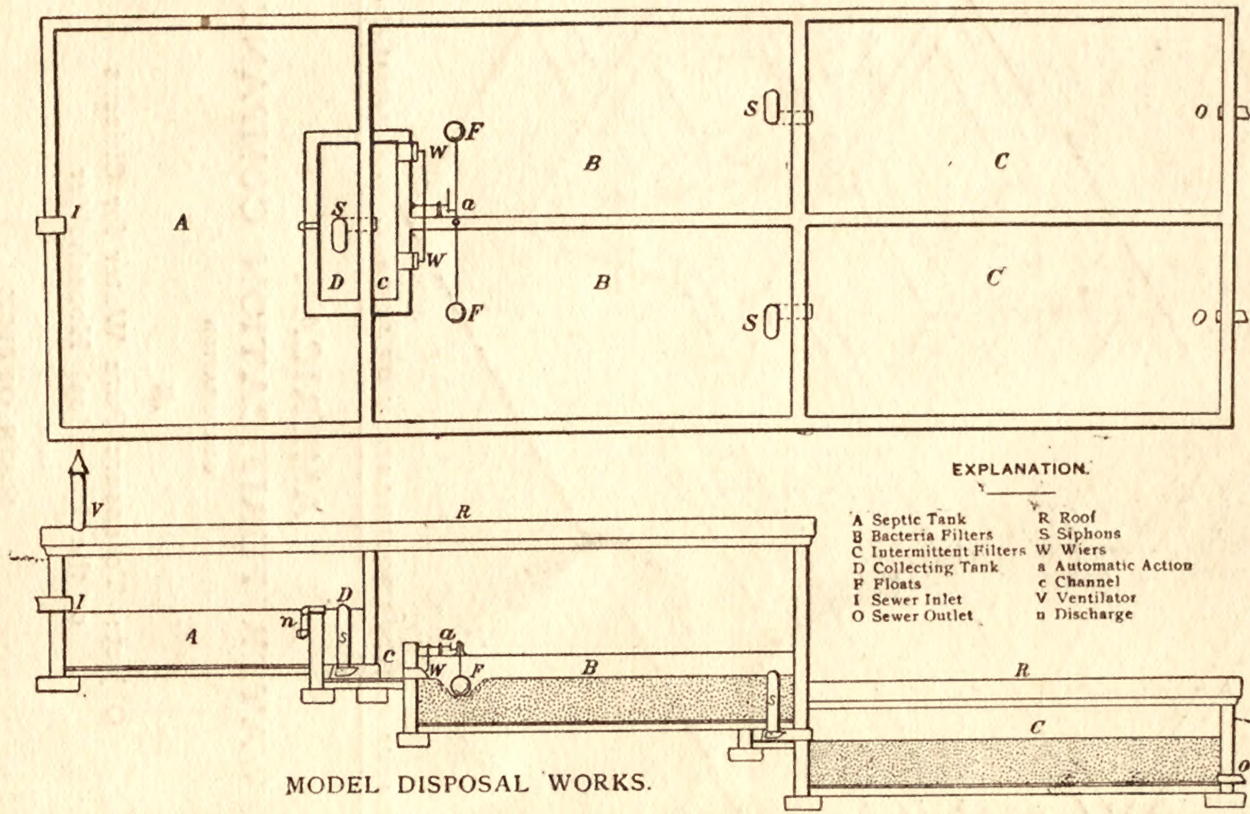
"*The Septic Tank Patents Again.*

"So far as we know, the Cameron patents have not been passed upon by the United States courts, nor any suits brought by the Cameron Company to test them. There is, however, a suit now pending against the city of Plainfield, N. J., brought by the American Sewage Disposal Company of Boston, Mass., Mr. John N. McClintock, president and manager. Mr. McClintock claims that the septic tank and double filtration beds at Plainfield are an infringement of patent number 559522 (May 5, 1896), granted to the late Amasa S. Glover, and now controlled by the company named. He also claims that the principles underlying the septic tank were discovered by Mr. Glover prior to Sept. 7, 1881, and before the date of the French patent of the Mouras Automatic Scavenger and that United States patent number 258744 (May 13, 1882) covered septic action."

The corporation is aware of its rights and is willing to sustain them by recourse to the proper courts.



APPARATUS FOR THE PURIFICATION OF SEWAGE. U. S. Patent No. 719357.




MODEL DISPOSAL WORKS.